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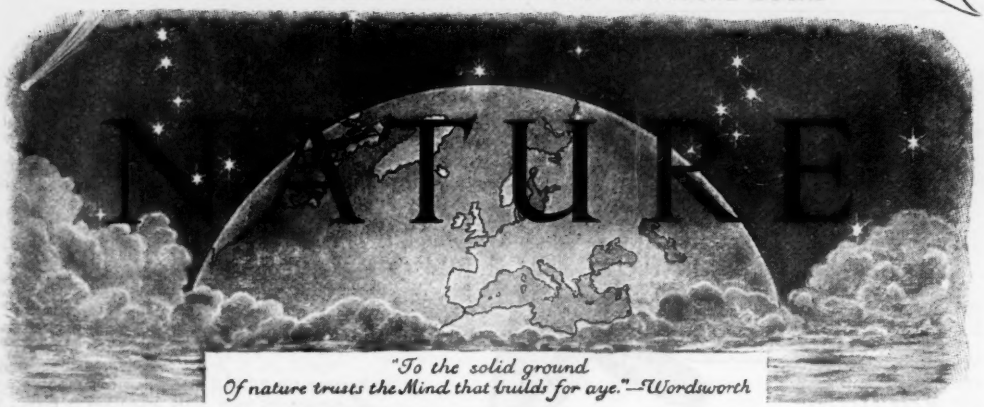

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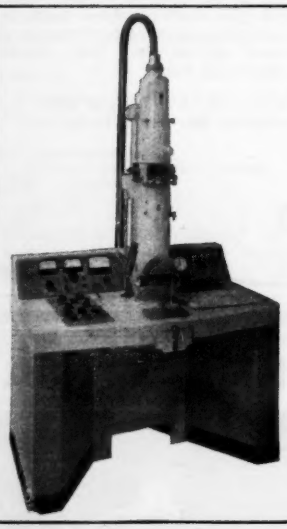

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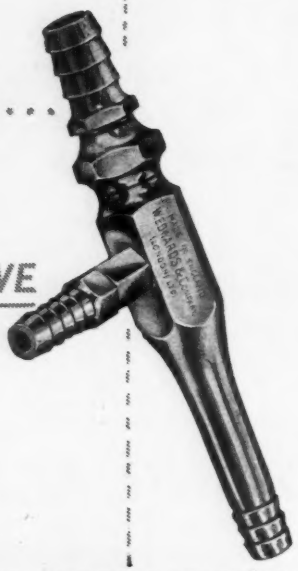

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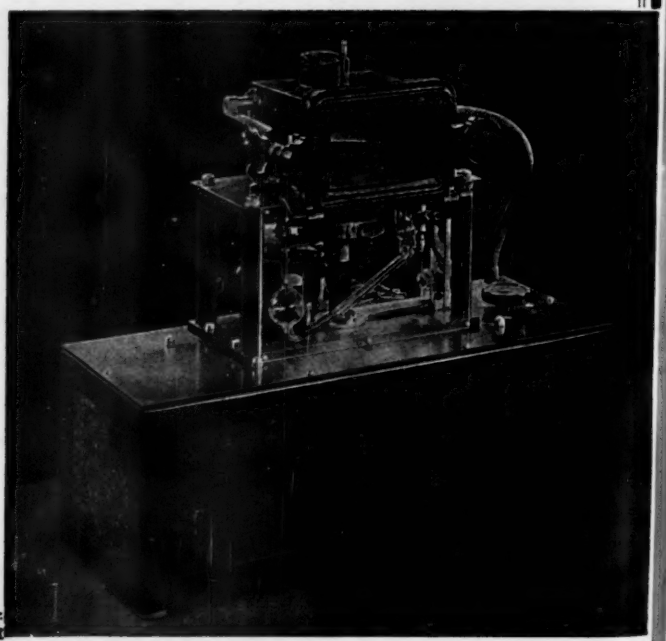

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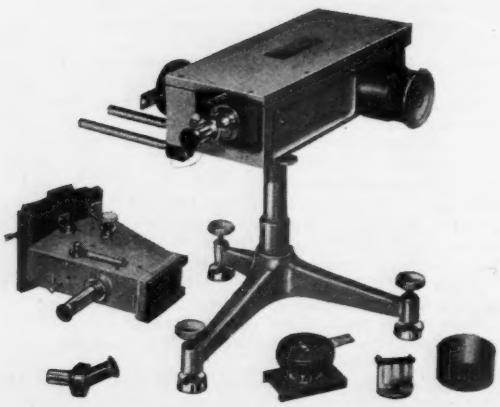

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CONSERVATION OF SCENIC BEAUTY IN BRITAIN

THE Nature Conservancy has now firmly established its value as essentially a scientific body, the work of which is of great importance to agriculture and forestry, water supply, coastal defence and meteorology, and indeed to the use and development of land in Britain generally. An increasing proportion of its annual report summarizes the results of scientific research, much of which is already of value in many departments of the national life and indeed could be of even greater value if undertaken on a greater scale and followed up effectively. How valuable are the findings of ecological research and the management of nature reserves in general policy and practice in the use and management of land received notable demonstration at the Conference of the International Union for the Conservation of Nature and Natural Resources at Edinburgh last June, to which the Nature Conservancy and the Society for the Promotion of Nature Reserves were joint hosts. On one hand, this Conference enabled representatives of engineering, town and country planning, forestry and agriculture to discuss in some detail the technical problems posed for them by ecological knowledge; on the other hand, it gave plant and animal ecologists, physiographers and others a much clearer and broader insight into problems of the use and administration of land.

Neither in Britain nor overseas do those responsible for nature conservation fail to recognize an obligation not only to conserve important sites and to study the biological and other problems involved, but also to make their knowledge freely available in terms intelligible to those who have responsibilities affecting the use or management of land. In written evidence submitted in May last to the Royal Commission on Common Land, the Conservancy attempted, for example, to show not only the scientific importance of common lands but equally the great possibilities of combining several different types of competing use, including nature conservation. The emphasis in the work of the Nature Conservancy has, in fact, now shifted to the execution of a carefully planned and well-scrutinized programme of research, to the digestion and application of ecological and other knowledge which has been gained or is currently emerging, and to the improvement of its liaison, educational and advisory services. The Conservancy is becoming more fully acquainted with the requirements and problems of neighbouring authorities and interests, and thus increasingly competent to contribute effectively to shaping sounder principles and practices, particularly in the use and management of land.

With this promising prospect, and in spite of the potential advantages of its work to the nation in furthering the wise use of the very limited resources of land, the work of the Conservancy is sharply threatened from two directions: the unwillingness of the Government to provide reasonable resources and the continual encroachment of development. In regard to the latter, the Conservancy comments in its latest annual report (see p. 404 of this issue of *Nature*) that "experience has strikingly confirmed that no area in the country can be considered even moderately safe from threat of destruction at a few months' notice". Fresh examples are cited in this report. In one, the Carstairs Kames in Lanarkshire, an area which has been under consideration by geologists as a possible national nature reserve, the Conservancy concluded that it could not justify asking for the large sum of public money needed to acquire and sterilize the deposits, although they are the best known and most intensively studied Scottish example of such glacial remains. No compromise was possible which would preserve the scientifically most valuable section, having regard to the rights of the different owners and holders of gravel concessions, and the Secretary of State for Scotland has in the circumstances authorized the proposed gravel working. Accepting the Government's decision, the Conservancy has accordingly withdrawn the formal notification of the area as a 'site of special scientific interest'.

This case is disturbing, because it was handled with much care and thoroughness, and it is difficult to see how any of those concerned could in the circumstances have acted otherwise. Such cases, moreover, are likely to recur, particularly in relation to geological sites, since the glaciers which created the high scientific interest of the deposit simultaneously gave it a high commercial value, payment of compensation for which would be far beyond the financial resources of the Nature Conservancy. A similar clash of interest concerning geology and physiography is involved in preservation of the Parallel Roads of Glen Roy, Inverness-shire, regarded as providing one of the most important natural monuments of ice age phenomena in the United Kingdom, and which are now threatened by afforestation. Discussions are still continuing between the Conservancy and the Forestry Commission with the object of reconciling the Conservancy's desire to ensure the permanent preservation of a minimum of some 9,000 acres as a geological monument with the Commission's urgent need for more land for planting.

Each case such as that of the Carstairs Kames, however, enforces the need for a sense of perspective and balance. The total acreage of the nature reserves in England and Wales is still no more than 82,662 acres, or less than 0·1 per cent of the land area, and much of this is at too high an altitude to grow trees or carry human habitations, while most of the rest consists of coastal sand dunes, shingle beaches and mud flats which can be used more productively for science than for any directly economic purpose. Both the Nature Conservancy in its annual report, and the National Parks Commission in its seventh annual report (see p. 405 of this issue of *Nature*), refer to the

helpful attitude of Service Departments and public corporations (with a few notable exceptions) and the efforts made by both sides to reconcile conflicting interests.

Neither for the Nature Conservancy nor for the National Parks Commission is it reasonable to allow particular cases of amenity or scientific interest to be settled entirely in isolation. Further clashes between the scientific interest of a glacial deposit and the exploitation of a gravel deposit should not be determined without taking account of what has already been destroyed and what is demanded elsewhere. The claims of amenity and of science at particular points, and seen against national and not sectional or local interest, must come first; otherwise neither the National Parks Commission nor the Nature Conservancy can work.

When this obtains, however, the question of compensation or cost should not fall on the Conservancy or the Commission but on the nation as a whole. Before considering this point further, it should be noted that while it is here that the effectiveness of the National Parks Commission is most gravely threatened, the financial danger to the Conservancy arises directly from Government parsimony. For the whole of its work the Conservancy will receive no more than £280,000 in 1956–57, and it is not surprising that scientific programmes have again been restricted and work on the development and maintenance of reserves postponed, or that no further new grants will be made before 1958–59. Moreover, applied ecology, as the report points out, requires a series of carefully selected and undisturbed sites on which different possible treatments and practices in the use of land can be carried out and observed, just as new strains of cereals or new practices in rearing livestock are tested on experimental farms. The national nature reserves are intended to provide for such experiments, in addition to their function in conserving wild life; and this can only be done if sufficient man-power and resources are available. Such treatments are in progress on some of the reserves, but only on a very small scale; and the report admits that the greater part of the opportunities cannot be followed up for want of money.

This state of affairs is unworthy of Great Britain, and to say the least, reflects no credit on the Government or on the Minister primarily responsible, the Lord President of the Council, nor the Committee of the Privy Council for Nature Conservation, to which the Director-General of the Nature Conservancy is secretary. The sums concerned are too trivial in relation even to the expenditure in related spheres, quite apart from the fact that, as both the Conservancy and the National Parks Commission emphasize, opportunities and possibilities are being lost irretrievably through development. Failure to provide the Conservancy with funds sufficient for its modest research programme to be carried out efficiently and expeditiously is short-sighted and wasteful of the nation's precious resources.

The National Parks Commission is likewise handicapped and frustrated from lack of resources. Here, however, the position is somewhat different. The financial difficulty is linked directly with the threats offered by development; but once again it arises essentially from the failure of Minister and Government to implement the provisions which Parliament wrote into the Act, as is well brought out in the current report in the comments of the Commission on development questions and on the possible amendment of the Act.

Like the Nature Conservancy, the National Parks Commission emphasizes its continuing concern at the growing demand for the use of sites in national parks and like areas for projects which threaten to despoil the countryside. Some 1,550 such development questions were considered during the year, some of which, like the Atomic Energy Authority's proposals to establish a research station in Dorset, are a reminder of the increasing tax which the development of nuclear power must take of amenity and of other claims on the use of land. Afforestation, mineral workings, water schemes, Service requirements and electricity undertakings, as with the nature reserves, involve demands as difficult to reconcile with the claims of amenity as with those of scientific work, and the genuine efforts made to find a compromise and reconcile opposing interests all too frequently fail.

As with the nature reserves and sites of special scientific interest, what is required if the national parks are to mean anything is some authority competent to take a long view, to see particular proposals against the full perspective of national needs in general, including amenity, and of the sacrifices already made, the concessions already received—an authority, too, with the power and resources to see that the necessary compensation is provided as a national charge if appropriate. The intention was clear enough when the Act was passed, but successive Ministers of both major political parties have consistently failed to provide the National Parks Commission with either the resources or the full authority needed.

The position is sufficiently illustrated by reference to the question of electricity supply discussed in the Commission's current report. Holy Island and some of the choicest parts of the Lake District, as well as other areas of exceptional beauty, are threatened by proposals to construct overhead lines. In more than ninety per cent of the cases raised, agreement is reached with the electricity authority on the procedure to be followed, and the National Parks Commission does not claim that, even in national parks, electricity lines ought, as a matter of course, to go underground. It considers that each proposal should be examined individually and studied on its merits, and it also holds that there are some areas of such outstanding beauty as landscape that the highest standards should be applied and it feels bound to press for underground lines. The additional expenditure involved would be insignificant in relation to the total finances of the undertakings; and, by implication, the report strongly condemns the shabby attempts made by some electricity boards

to inflict a surcharge on a small area of consumers to meet an expense incurred for the general benefit.

In particular, the Commission in this report firmly rejects the view that it or the park planning authority should agree to the construction of an overhead line, on the plea that it will be necessary on financial grounds to postpone the project, even indefinitely, if the necessary permission is not forthcoming. Once the authorities which are charged with the interests of amenity reach the conclusion that, on landscape grounds, the line should go underground, the Commission holds, and rightly, that it is wrong for those authorities to assent to its going overhead merely because the developer claims that he cannot afford to put it underground either in the immediate future or at all. To accept any other conclusion places the developer in possession of the final word, and the Commission notes, as a point of importance, that while the Minister responsible may decline to sanction an overhead line, he cannot compel the electricity authority to place a line underground.

Strong support for these views of the National Parks Commission was forthcoming from Lord Hurcomb, who was chairman of the Electricity Commission during 1938–47, in a debate in the House of Lords at the end of last July. Lord Hurcomb, submitting that even high-voltage lines should sometimes be put underground to avoid unpleasant interference with landscape, added that he did not accept the view that the preservation of amenity was a kind of social service which should not be placed on the industry causing the interference but be borne by the tax-payer or rate-payer. He submitted that an industry which could claim and get these wayleaves right across the country could reasonably be asked to bear, and throw on its own consumers, the costs; such costs, he claimed, would be negligible when spread over the whole body. More attention, he thought, should be paid to amenity than had been done in the past, particularly by a nationalized industry.

When, therefore, the Lake District Planning Board approves a scheme for overhead cables at the head of Great Langdale in place of referring the matter to the Minister as urged by the National Parks Commission, because the North-Western Electricity Board had promised an earlier supply if it were allowed to use overhead cables, we find the real hard proof that the present arrangements for the local administration of national parks are failing to achieve the intended purpose of the National Parks Act. The Permanent Secretary to the Ministry of Housing and Local Government, when addressing the Sheffield and Peak District Branch of the Council for the Preservation of Rural England last June, affirmed unequivocally the Minister's intention to implement the Act, although she admitted that the Act was in some respects experimental. The Minister's own reception of the Commission's actual proposals for the amendment of the Act was less promising. While in general sympathetic with the broad objects of the proposals, he held out no hope of legislation at present, nor was he prepared to take proposals for new expenditure to the Treasury, though he agreed that it was right to form ideas and to have plans ready for a long-term policy.

Events, however, give urgency to the needs of the National Parks Commission and also to those of the Nature Conservancy, and make nonsense of such procrastination. The amendments recommended by the National Parks Commission relate mainly to expenditure. Expenditures incurred by park planning authorities under Section 11 of the Act should earn grants, and the limit of grant to 75 per cent should be removed; provision should be made for grant both towards the administrative expenses of national parks and also for administrative expenses incurred by local authorities in completing the 'long distance routes', as well as for compensation to developers in national parks and areas of outstanding natural beauty. Without such resources the National Parks Commission is largely powerless in face of the threat of development, which does not stand still while Ministers delay. The Commission's report, like that of the Conservancy, shows above all the danger that the situation may well be lost irretrievably before the Ministers responsible are prepared to urge on the Government the provision of adequate resources for both bodies.

The chief note of hope is to be found in the increased attention which both Conservancy and Commission are giving to publicity of one form or another. Both reports record encouraging response to the greater efforts now being made to arouse public interest and understanding of their work. The Conservancy has already assembled a group of amateur naturalists to discuss problems which conservation presents, and this should be a line worth pursuing; while scientists might also seek to bring pressure to bear on the Lord President of the Council, whose apparent neglect may well be partly a consequence of the inadequate staffing of his office and the burden of his many responsibilities. The position of the Nature Conservancy is indeed one of the minor items contributing to the view that a re-organization of the national research effort is required; but the main need of the Conservancy, as of the National Parks Commission, is for the firm and understanding support of public opinion, which will insist on the Government giving adequate financial and administrative resources to enable these bodies to function effectively and to safeguard, before it is too late, Britain's priceless heritage of scenic beauty and scientific interest.

LEARNING AND INSTINCT

Learning and Instinct in Animals

By Dr. W. H. Thorpe. Pp. viii+493+9 plates. (London: Methuen and Co., Ltd., 1956.) 55*s*. net.

THIS important and somewhat overwhelming book deserves a detailed review because it is likely to have a significant impact upon psychologists and ethologists alike. For American psychologists it may be accepted as the principal formulation of the ethological point of view; and ethologists in

Great Britain and on the Continent may regard it as an authoritative presentation of the experimental and theoretical approach championed by American psychologists. The volume is divided into three sections. The first, consisting of 48 pages, deals with the philosophy of the science of behaviour, and with the subject of drive and the theory of instinct as espoused by some ethologists. The second section of 110 pages is devoted to an analysis of four or five different types of learning as conceived by Dr. Thorpe. The final section of 255 pages surveys evidence concerning the learning abilities of the main animal groups from protozoans to mammals.

For Dr. Thorpe the central problem of ethology is the relation between purposiveness and directiveness of behaviour. The ethologist is principally concerned with determining how much of an animal's behaviour is purposive and how this behaviour is related to the remainder. To say that behaviour is purposive means that it cannot be fully explained by mechanisms known to be operating in the body of the animal. Emphasis is laid upon the fact that one cannot consider an animal merely as a physico-chemical mechanism, but must conceive of it as a vital system. It is held that both objective and subjective approaches must be used in behavioural analysis. Subjective concepts derived from introspection are essential tools in achieving the main objective. If my impression is correct, this emphasis upon purposiveness, directiveness and subjectivity is not characteristic of all ethologists. N. Tinbergen, for example, appears to take a somewhat different point of view.

Learning is defined by Dr. Thorpe as "that process which manifests itself by adaptive changes as a result of experience" (p. 49). One might here raise questions about maladaptive learning, which certainly occurs in human beings and produces neurotic manifestations. It is Thorpe's opinion that there are several different kinds of learning which presumably are mediated by different kinds of physiological processes. First is 'habituation', which is a form of simple learning not to respond to stimuli which tend to be without significance in the life of the animal. Habituation is reflected by a relatively permanent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement. Habituation is compared to Pavlov's 'internal inhibition' and Hull's 'reactive inhibition'. 'Associative learning' is exemplified by conditioning and by trial-and-error learning. It depends upon the establishment of stimulus response bonds and is strengthened by the Law of Effect.

'Latent learning' consists of "the association of indifferent stimuli or situations without patent reward" (p. 107). 'Insight-learning' refers to "the sudden production of a new adaptive response not arrived at by trial behaviour or the solution of a problem by the sudden adaptive reorganization of experience" (p. 100). 'Insight', as distinguished from insight-learning, consists of the apprehension of relations. Evidence for the occurrence of insight and insight-learning is revealed by the use of tools by animals, by the performance of laboratory rats on detour experiments, by the 'reasoning' tests which Maier and others have applied to rats, by the occurrence of delayed responses, etc. These involve higher mental processes, possibly including ideation. Experiments with multiple choice tests strongly suggest, according to Dr. Thorpe, the occurrence of insight and ideation. This suggestion is strengthened by studies which demonstrate the existence of a 'number sense' in some mammals and birds. "This astonishing work . . . seems to have proved beyond question the existence of ideation in animals" (p. 119). 'Imprinting' is seen as a rather special kind of learning which has some affinity with both habituation and insight learning.

'Insight', 'perception' and 'instinct' are closely related. It is first assumed that insight consists of the perception of relations and is therefore linked up with perception as a whole. This in turn brings up the problem of instinct, since instinct involves complex innate perceptions. The next point is that perception involves learning because it is based upon comparison, and comparison involves learning. The conclusion is therefore that the differences between inborn and acquired behaviour are ones of degree rather than of kind.

This second section of the book concludes with an extensive discussion of the mechanism of learning. The treatment is exceedingly complex at points, but involves a good deal of ingenious reasoning. The final conclusion is that learning probably depends upon structural changes at the level of the synapse, plus the facilitatory effects of reverberating circuits within the central nervous system. It is further suggested that behaviour which initially depends upon learning may, in the course of evolution, become instinctive. This seems to be the 'lapsed intelligence' theory of instinct initially championed by Lamarck and now presented in more modern neurophysiological terms.

The third major subdivision of the volume suffers somewhat from uneven emphasis. This can be seen from a simple catalogue of the number of pages devoted to various groups. The allotment of space is as follows: protozoa and lower metazoa, 15 pages; worms and molluscs, 25 pages; arthropods, 55 pages; fishes, 37 pages; amphibians and reptiles, 12 pages; birds, 94 pages; and mammals, 20 pages. In part this irregularity is due to inequalities in the available evidence, but this is not the complete explanation. Another source of bias is related to the author's determination to pass lightly over laboratory studies which, in his opinion, have no bearing on the problems and circumstances which the animal encounters in the wild. This decision effectively rules out at least 75 per cent of the published studies which have been devoted to laboratory experiments on a few species of mammals. Nevertheless, a tremendous body of literature is summarized in this section and much of it will be new and revealing for the laboratory psychologist.

It is concluded that habituation or something very much like it occurs in protozoans such as *Paramecium*. There have been a number of controversial experiments designed to demonstrate the occurrence of associative learning in protozoans, but Prof. Thorpe feels that for *Paramecium* at least, it is "a fairly safe conclusion that true learning has been demonstrated" (p. 167). Habituation and some slight degree of associative learning probably also occur in echinoderms. In his treatment of learning in worms and molluscs other than cephalopods, the author is led to conclude that rudimentary associative memory is present in *Leptoplana*, and that annelids show habituation and associative learning. The same is true for Mollusca, which group is also capable of latent learning as demonstrated by the occurrence of homing in limpets. Cephalopods are apparently quite highly developed in that they show habituation, associative learning and possibly insight-learning.

Habituation, conditioning, trial-and-error learning, and latent learning all are demonstrated by various species of arthropods. The ability of the wasp *Philanthus* to recognize artificial landmarks placed around the openings of its burrow is referred to as latent learning. Other wasps such as *Ammophila* are said to display insight-learning when they carry or drag their prey to the nest hole, traversing a terrestrial route which they have never explored, save from the air. Other examples of highly organized behaviour include the detour performance of the higher Hymenoptera and certain aspects of nest repair of bees and wasps.

Various kinds of learning are said to influence the natural behaviour of fish. For example, Dr. Thorpe suggests that the schooling behaviour of some species depends in part upon a process something like imprinting. The same is said of certain elements in the reproductive patterns. Latent learning, habituation, conditioning, trial-and-error learning, detour behaviour, maze learning and delayed reaction are all discoverable in the activities of various fishes. With respect to 'memory', the author says, "some species of salmon and trout must be able to retain memories of the characteristics of their home stream for four years or more" (p. 280). In addition, latent learning and insight-learning are said to occur in this class. In general, amphibians and reptiles are inferior to fishes in learning ability. However, some amphibians appear capable of habituation, associative conditioning, trial and error and latent learning. The latter is demonstrated, according to Thorpe, by the homing ability of some toads. There has been no critical work on habituation or latent learning in reptiles, although some species are known to be capable of establishing conditioned reflexes and of mastering simple problems through trial-and-error learning.

Practically all Dr. Thorpe's different varieties of learning occur in birds. Habituation, conditioning and trial-and-error learning appear under natural conditions. For example, it is stated that in the drinking of pigeons and nest building of young ravens an element of trial-and-error learning is involved. Under laboratory conditions the solution of puzzle boxes, the learning of mazes and probably insight-learning have been demonstrated. The establishment of territories under natural conditions involves latent learning. Various experiments are cited to demonstrate the establishment of a concept of number in birds. It is stated that they are able to discriminate numbers simultaneously and successively as efficiently as human beings can do when counting is prohibited. Dr. Thorpe considers it possible that parrots "are at the beginning of acquiring a real language". Some of the author's own experiments employing the sound spectrogram to analyse bird songs demonstrate convincingly that parts of the species' song are acquired as a result of experience involving exposure to the singing of adult birds.

In introducing the topic of learning in mammals, Thorpe states that it is unnecessary to attempt an exhaustive treatment because the topic of mammalian learning has been well reviewed a number of different times. He says further that in mammals, where learning power is so great and ubiquitous, it is a reasonable assumption that behaviour is learned. "Thus the onus on the experimenter is to prove that any given piece [of behaviour] is instinctive, and until this has been done the assumption that it is learned must be adhered to" (p. 393). He therefore takes as his task the consideration of examples of mammalian behaviour which there is some reason to believe is innate. The examples selected include sexual behaviour in rats, maternal reactions in rodents of various species, following responses in young ungulates, hoarding in rats, nest building in rats, toilet and grooming behaviour in the dormouse, territorial defence in the dog, emotional expression by posture and facial expression in the wolf, and certain innate motor patterns in chimpanzees.

In conclusion, Dr. Thorpe states his conviction that biology is becoming a more and more unified science and winning its independence from the physical sciences. In biology the phenomenon of emergence in which the whole is seen to be more than the sum of its parts is fundamental. Analysis to ever finer levels of structure will not reveal the nature of relations between the parts. Ethology emphasizes the unity of biology and stresses the importance of the holistic concept. Relations between man and animals are so numerous and important that no clear-cut dichotomy can be described. Further study of animal behaviour may eventually aid in the ordering of human social relations. Prosecution of further ethological studies will provide a more adequate theory of knowledge and strengthen the position of a philosophy of organism. It should in addition clarify the inadequacy of empiricism as a full philosophy of Nature.

This is not an easy book to evaluate. It is, as was said at the beginning, overwhelming in the sense that it presents a tremendous amount of evidence concerning the instinctive and learned aspects of animal behaviour. The authorities quoted range from Pliny the Elder to D. O. Hebb. The kinds of sources involved extend from anecdotal accounts received in personal correspondence to elaborate laboratory investigations conducted under systematic and controlled conditions. The central theme is most convincingly and strongly developed in connexion with those classes or groups with which Prof. Thorpe has worked directly, namely, insects and birds. The treatment is weakest in the area to which ethologists have as yet devoted relatively little attention, namely, that of mammalian behaviour. Few psychologists will feel that the topic of learning in mammals has received adequate consideration in this book. On the other hand, as noted earlier, the presentation of the classical ethological point of view and the buttressing of this conceptual framework with a variety of kinds of evidence is most impressive.

All in all, the book's weaknesses are greatly outweighed by its strong points, and I predict that it will be an influential volume for many years to come.

F. A. BEACH

VERTEBRATE EMBRYOLOGY

Development of Vertebrates

By Prof. Emil Witschi. Pp. xvi+588. (Philadelphia and London: W. B. Saunders Company, 1956.) 59*s*. 6*d*.

PROF. E. WITSCHI'S book is a text for "pre-medical students and zoology majors". Nevertheless, coming from a man who has made his own distinguished contributions to the subject it is bound to attract the attention of every embryologist. He does not succeed in disguising from us that he is above all an investigator, interested in the unknown

and the obscure as well as in the known. At times he even goes so far as to deal with matters such as the glycogenic body of birds that must be beyond the immediate needs of his 'majors'. Because of this, he has written an interesting book, which leads one on from page to page and picture to picture. There is a very welcome emphasis on the physiological processes at work during development, and especially on the energy sources available.

Those who value Witschi's own work on determination of the gonads will find here an excellent concise account of the subject. Indeed, they may wish that he had allowed himself to discuss the controversial aspects more at length, especially in relation to mammals. The account of the relation of genetics and embryology postulates that since "all cells of an embryo receive identical sets of chromosomes", but nevertheless differentiate into diverse organs, "a supplementary category of differentiating factors must be contained in the egg most likely not in the nucleus". A discussion of the evidence for the plasmagenes would have been welcome at this point. Moreover, the author allows a peculiar hint of recapitulationism to enter his discussions. He would probably deny that he believes in the inheritance of acquired characters, but in his text he is at times unguarded.

The account given of morphogenetic movements and gastrulation may prove confusing; for example, the old concept of concrescence has been reintroduced and amphibians are considered to possess a primitive streak. The treatment of the problems of induction is not as complete as could be wished. There is no clear statement about the epigenetic appearance of differentiation, and little reference to the work of, for example, Toivonen or Nieuwkoop. Admittedly, the subject is obscure and the author may have felt it unrewarding for students. Unfortunately, much of embryology is in this state nowadays, and no honest teacher can avoid letting the student see this. Prof. Witschi would certainly not consciously wish to do so; the richness of his knowledge would make it impossible for him. Perhaps it is a symptom of American college education that at times one feels he has tried to make the story clearer than it is. Nevertheless, there can be few who will not learn something from his lucid descriptions and excellent illustrations. J. Z. Young

THE VOYAGES OF CAPTAIN COOK

The Journals of Captain James Cook on his Voyages of Discovery

Edited from the original manuscripts by J. C. Beaglehole, with the assistance of J. A. Williamson, J. W. Davidson and R. A. Skelton. Vol. 1: The Voyage of the *Endeavour*, 1768–1771. Pp. cclxxxiv + 684 + 45 illustrations and maps. 80*s*. net. Portfolio of 58 Charts and Views drawn by Cook and his Officers and reproduced from the Original Manuscripts. Edited by R. A. Skelton. 50*s*. net. (Hakluyt Society, Extra Series, No. 34.) (Cambridge: At the University Press, 1955.)

THE great debt which geographers, historians of exploration, anthropologists and many others interested in scientific discovery owe to the Hakluyt Society is much increased by the publication of the "Journals of Captain Cook". The work is edited by Dr. John Beaglehole, a historian of Victoria University College, Wellington, who has devoted himself for many years to the study of the life and career of Cook as part of a wider interest in Pacific exploration. This first volume is a sumptuous production. It includes a coloured plate of Nathaniel Dance's portrait of Cook, as well as a number of world maps, maps of Pacific explorers' routes, portraits of Banks and Solander, reproductions of various drawings from the voyage, and of manuscript pages from Cook's own journal. It is accompanied by a magnificent portfolio of charts and views from the three voyages, reproduced from drawings by Cook and his officers, and edited meticulously by R. A. Skelton.

Captain James Cook, R.N., F.R.S., well merits such treatment; it is astonishing that he has not had it before. Three times he circumnavigated the globe. He was the first to cross the Antarctic Circle and to chart the north-west coast of America. In the scientific field his observations are still worthy of consultation, and in the practical field he had the great achievement of being able to undertake very long sea voyages and still preserve the health of his men. On his first voyage, apart from the expedition's observations of the transit of Venus at Tahiti in 1769 (for which Cook himself received a hundred guineas from the Royal Society as an observer), he circumnavigated and charted the coast of New Zealand, discovered the east coast of Australia and explored a great part of the Great Barrier Reef.

This volume is built around an admirable edition of Cook's "Journal" kept on the voyage of the *Endeavour* during 1768–71. The "Journal" is primarily a workmanlike account of the voyage, with a great deal of detail about positions, winds and weather, and nature of coastlines. But it also contains, apart from much exciting information about discovery, a great deal of material about the ethnography of the peoples in the various places visited. Yet, in the words of the editor, "the study of Cook's journals is not plain sailing". Cook, although he entitled this "Journal" "Remarkable Occurrences on Board His Majesty's Bark *Endeavour*", seems to have had no idea that such a work could have a popular appeal. He took great care over it—as an example, his description of Rio de Janeiro was the result of much drafting and redrafting—but he was clearly thinking of the Admiralty and not of a wider public, and it lacks the clarity of a simple narrative. This complex task of clarifying obscurities in the text has been most carefully handled by the editor, who has added a great number of explanatory notes.

Around the "Journal" are also set various introductory essays and appendixes. A general introduction explains the significance of Cook's voyage in the context of Pacific exploration of his age. Another introduction discusses the fitting out of the *Endeavour*, the selection of the crew, the orders for the voyage and its main accomplishments; it also examines some of the navigational points involved and refers to the mass of scientific material brought home. A textual introduction to the "Journal" explores the history of each of the four main manuscript copies, collates them and discusses also an impressive set of subordinate manuscript and printed sources. There is also a note discussing the state of Polynesian society, especially in Tahiti, at the time when Cook made his visits. Appendixes give Cook's letters and reports describing the voyage, papers of the Royal Society relating to the task of observing the transit of Venus in 1769 (the Society appears to speak of

Captain "Cooke"), and a set of Cook's manuscript drafts and variant versions which do not appear in his final "Journal". There are also extracts from several journals of the voyage kept by other members of the ship's company, a list of all documents known to bear directly on the voyage, and newspaper extracts indicating the background of intellectual and public interest in what was done.

The reader would be hard put to it to find matter for criticism in the editor's treatment. As a small instance, an anthropologist might regret that the editor has chosen to lend some support to a rather old-fashioned view of the history of Tahitian society, but even here he has guarded himself by a cautionary note. This formidable work is therefore balanced and most informative. It helps us to realize not merely what Cook did but also how he did it and the circumstances in which his achievement was made. In particular, it also shows us what manner of man Cook himself was—his modesty, his fairness, his quiet pride in his cartographical work, his administrative efficiency, his care for his ship and his men.

Dr. Beaglehole's editorial task can only have been accomplished as a labour of love. But it is also a monument of fine scholarship, distinguished for its penetration and its quiet humour as well as for its breadth and sensitive handling of sources.

RAYMOND FIRTH

GEOLOGY OF URANIUM

Proceedings of the International Conference on the Peaceful Uses of Atomic Energy

Held in Geneva, 8 August–20 August, 1955. Vol. 6: Geology of Uranium and Thorium. Pp. x+825. (New York: United Nations; London: H.M. Stationery Office, 1956.) 9 dollars; 63*s*.; 39 Swiss francs.

Exploration for Nuclear Raw Materials

Edited by R. D. Nininger. (The Geneva Series on the Peaceful Uses of Atomic Energy.) Pp. xv+293. (Princeton, N.J.: D. van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1956.) 55*s*. net.

Contributions to the Geology of Uranium and Thorium

U.S. Geological Survey Professional Paper No. 300. Pp. vii+739. (Washington, D.C.: U.S. Govt. Printing Office, 1956.)

THROUGHOUT the past decade more geologists have been engaged in the search for resources of the fissile metals than in any other phase of geological activity except exploration for oil. As a direct result of this work, ore deposits have been found which are capable of sustaining, in the free world, a long-term production of at least 15,000 tons of uranium oxide annually, at a cost of £4 or less per pound—that is, close on twice the global output of silver, a metal marketed at roughly the same price. As an indirect result, the investigations have yielded immense contributions to fundamental geological knowledge, particularly in the fields of ore genesis, geochemistry, mineralogy and geochronology. Probably no other studies in the recent history of the earth sciences have been quite so far-reaching in their application.

In August 1955 the Geneva Conference on the Peaceful Uses of Atomic Energy released a flood of information, some of it hitherto confidential, on the results of these geological researches. The official record comprises 125 papers, ninety-eight on the natural occurrence of uranium and thorium and twenty-seven on methods of prospecting, submitted by twenty-two countries. The United States of America contributed eighty-five papers, Brazil seven, Great Britain five, and other countries one or two each. The U.S.S.R. sent in only two contributions, both on prospecting techniques; and its representatives rigorously eschewed all mention of the distribution and extent of ore deposits within the Soviet Union.

No more than a few papers can be mentioned here. The most noteworthy work is perhaps that of Derriks and Vaes of the Union Minière du Haut Katanga, who give a detailed account of the geology and metallogenesis of the famous deposit of Shinkolobwe in the Belgian Congo. This mine has yielded much more uranium than any other, but a comprehensive description of the primary mineralization has hitherto been lacking. Another paper, by Max G. White, points to the existence in Serra de Jacobina, Bahia, Brazil, of uranium-bearing auriferous conglomerates, mostly of sub-economic grade but otherwise similar to the great ore deposits of the Witwatersrand in South Africa and Blind River in Ontario. The successful reconnaissances carried out in France by geologists of the Commissariat à l'Énergie Atomique are reviewed by Marcel Roubault; and Paul F. Kerr has furnished, on behalf of the United Nations, a 54-page summary of the various reports presented to the Congress and of pre-existing literature.

The preponderance of American contributions could well lead an uninformed reader to the conclusion that the world's principal resources of uranium and thorium lie within the United States. The deposits of Canada, wherein rests the greatest potentiality for future low-cost production, are referred to no more than incidentally, perhaps because they have already been so fully documented in geological literature. There is no geological contribution at all on the South African field, next to Canada in importance; but an account of the South African uranium industry is given elsewhere (Vol. 8) in the Conference Proceedings. Again, the several important Australian deposits are disposed of in a single brief paper. While the uraniferous phosphorites of Florida and Idaho attract four articles, the equally important low-grade resources of North Africa are scarcely mentioned; and the uraniferous black shales of America are the topic of more contributions than the richer shale deposits of Sweden occupy paragraphs. The lack of balance does not, however, alter the fact that this is the greatest accumulation of information on the natural occurrence of the radioactive elements that has ever been presented.

The United Nations' publication extends to three-quarters of a million words; and for the benefit of the non-specialist an excellent condensation of its most significant chapters has been produced by R. D. Nininger, assistant director (Raw Materials Explorations) of the U.S. Atomic Energy Commission. This very readable volume, complete with well-selected references, is likely to be a standard text for students and teachers, and for economic geologists, during the next decade. All the American contributions to the Conference, supplemented by data received too late for Geneva, have been reprinted as a Professional Paper of the U.S. Geological Survey.

C. F. DAVIDSON

Progress in Metal Physics

Edited by Dr. Bruce Chalmers and Dr. R. King. Vol. 6. Pp. viii+354. (London: Pergamon Press, Ltd., 1956.) 70*s*. net.

A REVIEW of such volumes as those that make up the "Progress in Metal Physics" series has to be approached in a rather special way. All research workers in the field will welcome the continuance of this series, having experienced the value of the growing library of specialist articles which the volumes provide: it remains to consider the contents of the latest addition. Mosaic structure (P. B. Hirsch) at last achieves an article in its own right, and succeeds admirably in tying together the various concepts which have emerged in attempting descriptions of imperfections. The filamentary growth of metals (H. K. Hardy), another very topical subject, is adequately, if rather briefly, surveyed. Knowledge is still too scarce to enable much more detailed discussion. Researches on the creep of metals extend widely from fundamental to extremely technological investigations, and a summary of recent advances could be extremely lengthy. By dealing with a limited number of contributions, particularly those with a more apparent physical significance, A. H. Sully has trimmed the subject very deftly into a reasonable form. The article serves to underline how very empirical the study is even to-day. Evaporation (O. Knacke and I. N. Stranski) and the austenite–pearlite reaction (R. F. Mehl and W. C. Hagel) each get a place, and one can only admire the skill with which much difficult material is handled and expounded. The effect of hydrostatic pressure on the electrical resistivity of metals (A. W. Lawson) appears at first all too specialist a subject for a full article, but it covers some surprising and interesting results and earns its place. Taken together, this is a good wholesome volume, with plenty of value in it, well balanced in its contents, and a welcome addition to the sequence. A. J. Kennedy

Kapitza

By A. M. Biew. (Translated by James Cleugh.) Pp. 288. (London: Frederick Muller, Ltd., 1956.) 18*s*.

THIS book, written in Germany by a refugee, purports to tell how the U.S.S.R. developed the hydrogen bomb with Kapitza as the principal scientist and with Joffe and Kurchatov (Kurtschatov) as his principal colleagues. The credibility of the book can be judged by the account in the second chapter, headed 'the first spies', of Kapitza's work in Cambridge. Practically every detail which can be checked is wrong. It is stated that by 1928 Kapitza "had already become in practice the head of the establishment", that is, the Cavendish Laboratory. This at a time when Rutherford was in his prime! The Royal Society Mond Laboratory, which was built for Kapitza's work, is referred to as the "Moon Laboratory". Sensational accounts are given of attempts to lure Kapitza back to the U.S.S.R. in the 1930's. In fact, he returned most years to see his mother and visit friends. It is stated that he married his second wife, Anna Krylov, in 1934 after he returned to Russia—whereas this took place in Cambridge in 1928. The sale by Rutherford of Kapitza's Cambridge equipment to the new Institute in Moscow is written up in a sensational and completely untrue way, and the sum paid for it is an order of magnitude higher than the actual sum. The book states that the Russian atom bomb project started in 1937. While we may be permitted to be sceptical about this, we can at least check the few brief paragraphs about the physics of the project. These appear to be just as bogus as the account of Kapitza's Cambridge period.

The book does not even qualify as science fiction.

J. D. Cockcroft

Bibliography of Solid Adsorbents 1943 to 1953

An Annotative Bibliographical Survey. By Victor R. Deitz. (United States Department of Commerce: National Bureau of Standards Circular No. 566.) Pp. vi+1528. (Washington, D.C.: Government Printing Office, 1956.) 8.75 dollars.

THIS bibliography of solid adsorbents represents in effect the continuation of an abstracting service for the subject of adsorption and of related topics. The first bibliography covered the period 1900–42, and the present one covers the interval 1943–53, and in addition includes some material omitted from the first. The scope of the bibliography may be illustrated by citing the chapter headings: adsorption of gases and vapours on solid adsorbents (277 pp.); adsorption from solution on solid adsorbents (266 pp.); thermal effects in adsorption processes (22 pp.); theories of adsorption (49 pp.); refining of sugar and other applications (527 pp.); general information on adsorbents and special methods of investigation (163 pp.); preparation of adsorbents (14 pp.). It is interesting to find a single field of physico-chemical endeavour emerging with its own abstracting service, and it is not surprising that it is the adsorption field which has so done. The technological ramifications of the subject are exceptionally far-reaching and important and are developing rapidly, while the volume of research in the subject is exceptional. The reviewer can recommend this volume as a valuable source of references and of information. R. M. Barrer

Emperor Penguins

By Jean Rivolier. (Translated from the French by Peter Wiles.) Pp. 131+16 plates. (London: Elek Books, Ltd., 1956.) 15*s*. net.

IN the southern spring of 1950 a French sledging party operating on the coastal ice of Adelie Land, Antarctica, discovered the fourth rookery of emperor penguins ever to be visited by man. Two years later a base was established on an island nearby, and the emperors were studied through their remarkable breeding cycle by the biologist, Jean Prévost. Seven men wintered in the hut at Pointe Geologie, and this book, by the expedition doctor, is a racy account of their successes and tribulations. A macabre sense of humour describes the activities of seven cheerful individualists in an unusual situation; in spite of the delightful cover photograph and uncompromising title, this is not primarily a book about emperor penguins.

Rather fewer than half the pages are devoted to descriptions, excellent at times, of the birds, of their slow courtship, huddled incubation, care of young and dispersal at the end of the year. It is discouraging, however, to find misleading clichés ("a small and dying race") and more than discouraging to see a clear photograph of an embryo with membranes *in vitro* over the caption "X-Ray photograph of the egg". It is hoped that Prévost himself will eventually fulfil the promise of his earlier papers with a full and complete survey of the breeding cycle.

B. Stonehouse

DAVID GREGORY'S COMMENTARY ON NEWTON'S "PRINCIPIA"

By Dr. W. P. D. WIGHTMAN
University of Aberdeen

IN the exhaustive study of "Newtoniana" which has been proceeding in recent years, one document, the interest of which is far from negligible, seems to have received too little notice: this is David Gregory's "Notæ in Newtoni Principia Mathematica Philosophiæ Naturalis", to give it the title inscribed in Gregory's own hand on the original manuscript now in the possession of the Royal Society. In a previous communication[1] I directed attention to the fact that two manuscripts are confusedly referred to in the literature and that I had discovered a third, to which there is no previous reference, in the Gregory Collection in the University of Aberdeen. After that communication, further research revealed erroneous[2] or incomplete[3] references which may be perpetuated by such recent authoritative works as Prof. H. W. Turnbull's "Tercentenary of James Gregory"[4]. When during the course of his researches into Newton's correspondence, Prof. Turnbull heard that a manuscript previously unknown to him was in the possession of the Royal Society, he very kindly informed me of the fact. The examination of this manuscript proved to be of more than merely antiquarian interest, as will appear hereafter. Lastly, through the courtesy of Mr. W. G. Hiscock, librarian of Christ Church, Oxford, I have examined a fourth manuscript, of which there is no previous mention in the literature[5]. Though it is now possible to clear up the confusions relating to this work, at least in respect of its connexion with Newton, a minor mystery has been revealed, which concerns a well-known figure of a century later. Before proceeding to these matters, it may be as well to recall the circumstances of the composition of the work.

The "Principia" was published in July 1687, and from the running dates on the folios of his original manuscript it appears that David Gregory began to write his "Notæ" in September of the same year while he was professor of mathematics at Edinburgh[6]: it is well known[7] that he was actually teaching the Newtonian philosophy there before he left to become Savilian professor of astronomy at Oxford in 1691. From the same manuscript it appears that the "Notæ" were substantially completed at Oxford in January 1693/4; and this inference is consistent with Gregory's entry in his diary: "I am not to revise my Notes on Mr. Newton's philosophy until there is a second edition of it by Mr. Newton himself, or that we despair of having one" (March 4, 1695/6)[8]. This 'revision' must be read in the sense of a complete revision for the press, since it is clear from the manuscript that Gregory added a considerable number of emendations. The majority of these are not separately dated, but one very near the beginning, referring to Newton's famous dispute with Hooke concerning the path of a freely falling body near the Earth's surface, contains the phrase "ut clarissimus Newtonus mihi narravit". This could scarcely have been written before Gregory left Edinburgh in 1691, but it is on a slip affixed to a folio, so may be presumed to have been added some years after the passage to which it refers. This addition is incorporated in the *texts* of the three transcripts already alluded to. A few additional notes were added up to February 28, 1697/8 (London), and the last entry in the manuscript refers to "21 Julii 1706"[9]; there is no further reference to the "Notæ" in the diary, which closes September 20, 1708; and before the end of the year Gregory was dead. It seems safe to assume, therefore, that no attempt was made in Gregory's lifetime to publish the "Notæ". Rigaud[10] states that it never was published, though he quotes a letter from Sanderson to the effect that proposals in regard to publication were then (February 4, 1713/4) under consideration. There are also some notes in a later hand on the Edinburgh manuscript about an actual announcement of publication, but Gregory's relative, into whose hands the manuscript later passed, stated that it had never been published[11].

It now remains to give an account of the four manuscripts known to be extant, with such comments as may be of assistance in saving any subsequent reader from the pitfalls which no one (including myself) has so far avoided.

(1) The Royal Society. MS. 210 is written throughout in David Gregory's hand. It is clearly the the one described by Rigaud[12] at a time when Duncan Farquharson Gregory, Fellow of Trinity College, Cambridge, allowed him to see it. It was presented to the Royal Society by John Gregory, presumably the eldest surviving son of the well-known Edinburgh physician, James Gregory, in November 1866; his covering letter is in the possession of the Royal Society. Although this is the original manuscript, it must be used with caution, since the large number of emendations afterwards added were in most cases written on slips affixed to the original folios. Collation with the Aberdeen manuscript aroused my suspicion that passages occurring in the latter were missing from the original. Careful examination revealed faint marks on certain folios corresponding to the sealing wax used for affixing some other slips. All deficiencies noted at the time were afterwards made good by photographic copies of the appropriate pages of the Aberdeen manuscript. Following on the main text are two inserted folios (dealing at length with a few propositions and lemmata) dated "Londini 28 Feb. 1697/8", which is four years later than the last date on the guard—"Oxoniæ 29 Jan." (1693/4). The latest date found in the manuscript has already been noted above. Much interest is attached to this manuscript, which alone of the four contains the pages copied from a manuscript attested by Gregory as "propria manu D. Newtonii", in which Newton had assembled from the ancient writers numerous opinions on the nature of gravity and on natural theology. The misunderstanding of Gregory's use of this manuscript (on which he drew generously in the preface to his "Astronomy", 1702) gave rise to the absurd statement[13] in Gleig's supplement to the third edition of the "Encyclopædia Britannica", which was later corrected by James Craufurd Gregory[14]. Newton's original manuscript is contained in the Gregory Supplementary Volume MS. 247, having with other papers been donated to the Royal Society by John Gregory in November 1866. Unfortunately, the

folios have been stuck into the volume in the wrong order.

(2) The transcript (MS. *DC*. 4. 35) in the University Library at Edinburgh is the only manuscript specifically referred to in the literature (except by Rigaud). The title is in Gregory's hand, as are the signatures at the foot of each page, also probably most of the diagrams. According to Gleig, this was donated to the University by "Dr. James Craufurd Gregory"; this may have been so, though the Library has no record of the gift. What is established, as a result of raising the binding paper from the front cover, is the presence of the book-plate of John Robison, first secretary of the Royal Society of Edinburgh. This discovery led to the identification, as Robison's, of the (incorrect) inscription "Scripta anno 1693 . . ." above Gregory's title. The text appears to be a reasonably close copy of the original, with the qualifications already alluded to. The last page, in two hands, both differing from Gregory's, raises interesting questions of provenance which cannot be discussed here. Prof. Turnbull believes the later hand to be that of Robison, though it is markedly different from the inscription on the title-page. For this opinion he adduces the fact that he has discovered marginal references to the "Notæ", corresponding to the pages in this manuscript, in the same hand in Robison's copy of the "Principia".

(3) The Aberdeen transcript manuscript calls for no special comment except in regard to provenance[15]. Suffice it to say here that it also has Robison's book-plate, and below the title is his (incorrect) inscription "anno 1693 conscriptæ". Why and how Robison should have possessed two manuscripts, in apparent ignorance of the existence of the original in the possession of the Gregory family, and how one of them returned to the University Library and the other to Fyvie Castle, can only be conjectured.

(4) The Christ Church transcript MS. *B*. 13. cxxxi is for the most part written in one hand, different from those of the other transcriptions, but it contains a number of additions in a hand which Mr. Hiscock believes to be Gregory's; these additions include some slips pasted on. What marks this manuscript out from the others is the cancellation, sometimes in contemporary ink, sometimes in pencil, of sections, one at least of which stands uncancelled in the Edinburgh manuscript. Such detailed collations as I was able to make show fairly marked divergences from the Aberdeen copy; these are, however, linguistic and not in respect of contents.

The conclusions which emerge from this study are that in any further research on the life and times of Newton these "Notæ" should not be neglected, but that it would be unwise to base such inquiries on any single manuscript. Though the problems of provenance of the manuscripts have not been solved, enough has been made out to show that the "Notæ" were actively studied at least until 1838. It is sad to think that from the time of its deposit with the Royal Society in 1866 the original manuscript passed into oblivion.

Throughout this protracted investigation I have been encouraged and guided by Prof. H. W. Turnbull; it would not have been possible at all had not Dr. Douglas Simpson, librarian of the University of Aberdeen, allowed me the unrestricted use of the Aberdeen manuscript as a basis of comparison. Mr. W. G. Hiscock, librarian of Christ Church, and Mr. C. P. Finlayson, keeper of manuscripts at the University of Edinburgh, assisted me with their special knowledge. Mr. I. Kaye, librarian of the Royal Society, and Mr. D. MacArthur, deputy librarian of St. Andrews, gave me special facilities for the examination of the Gregory manuscripts in their care. It is a pleasure to acknowledge so much assistance.

[1] Nature, **172**, 690 (1953).
[2] "Dictionary of National Biography", article "David Gregory".
[3] Rigaud, S. P., "Historical Essay on the First Publication of Sir Isaac Newton's Principia" (Oxford, 1838).
[4] Turnbull, *op. cit.*, p. 40.
[5] Except in Mr. Hiscock's most valuable but privately circulated "David Gregory, Isaac Newton and their Circle" (printed for the Editor; Oxford, 1937).
[6] For relevant information about the Gregory family, see Wightman, "Aberdeen University and the Royal Society", *Notes and Records of the Royal Society*, **11**, 148 (1955).
[7] Brewster, D., "Memoirs of the Life . . . of Sir Isaac Newton", **1**, 334 (Edinburgh, 1855).
[8] Hiscock, *op. cit.*, p. 4.
[9] Hiscock, *op. cit.*, agrees with this. Rigaud has "Junii".
[10] Rigaud, "Correspondence of Scientific Men of the Seventeenth Century", **1**, 234 (Oxford, 1841).
[11] Gregory, J. C., *Trans. Roy. Soc. Edin.*, **12**, 21 (1834).
[12] Rigaud, "Historical Essay on the First Publication of Sir Isaac Newton's Principia", p. 80 (Oxford 1838).
[13] "Encyclo. Brit.", Supplementary Vol. 1, 721 (1801).
[14] Gregory, J. C., *loc. cit.*
[15] Wightman, *loc. cit.*, p. 150. A gloss in the hand of the unknown first owner of the manuscript suggests that it was still in his possession as late as 1750.

AGRICULTURE AT THE UNIVERSITY OF KHARTOUM

By Frcp. R. J. McILROY
Dean of the Faculty

THE School of Agriculture at Shambat, a village situated about five miles from the city of Khartoum in the Sudan, owes its origin to the De La Warr Commission of 1937. A School of Agriculture had been proposed earlier by R. K. Winter, director of education during 1932–36, and M. A. Bailey, head of agricultural research during 1931–38, and buildings were erected in 1937 at the Gezira Research Farm at Wad Medani; but these were never occupied by the School, the Shambat site, within easy access to the Gordon Memorial College at Khartoum, the precursor of the new University of Khartoum, being wisely chosen.

The School started in 1938 with an entry of six students who were selected on completion of a two-year intermediate course in biology, physics and chemistry at the Gordon Memorial College. A three-year course in agriculture, the agricultural sciences and agricultural engineering led to the award of the College diploma. The course was designed to provide professional training for the agricultural officials required by the Sudan Ministry of Agriculture, and,

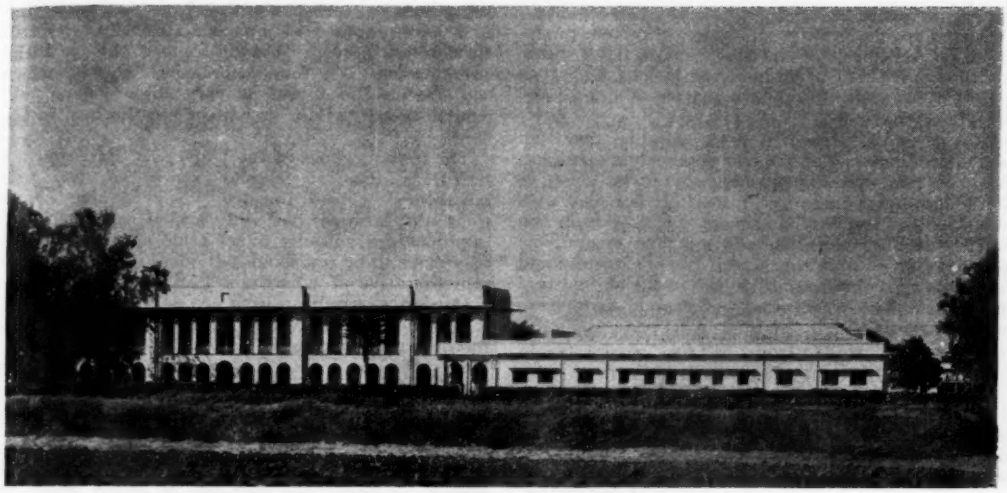

Fig. 1. Faculty of Agriculture, University of Khartoum

with this end in view, included in addition to the normal curriculum of agricultural colleges, surveying and agricultural engineering with special reference to irrigation farming.

The importance of familiarizing the student with the peasant farmer with whom he would eventually be working and with the traditional methods and social life of the people was recognized from the start, and vacation treks and camps for students have always formed an essential part of the course. For one month in the long vacation, students are attached to field inspectors of the Ministry of Agriculture and serve as assistants for this period. In the early days of the School many of the entrants were drawn from urban communities with little or no agricultural background. Pre-breakfast field classes, in which the students cultivate their own plots, become familiar with agricultural implements, primitive and modern, and learn something of field biology, are a means of overcoming this initial disadvantage.

In 1951 with the transformation of the Gordon Memorial College into the University College of Khartoum, which was admitted into special relationship with the University of London, the School of Agriculture became the Faculty of Agriculture and offered, in addition to the diploma course, an alternative course leading to the B.Sc. (Agric.) degree of the University of London. Teaching for both courses was identical, the difference being in standard. While entrants for the London degree course required a pass in the London intermediate examination, admission to the diploma course was permitted on possession of the intermediate of the University College—a local examination. External examiners for the diploma were drawn from the Sudan Ministry of Agriculture.

When in 1956 the College acquired full university status the two courses were combined in the B.Sc. (Agric.) degree of the University of Khartoum, with entrance standards as for the diploma and with examination regulations more closely related to those of the College diploma than of the London degree. No relaxation of teaching and examination standards is anticipated, and in the first year the University of London has generously agreed to provide external examiners for the Khartoum degree.

The syllabus has been slightly modified in an attempt to meet the requirements of the Sudan for both agricultural officials and research workers and at the same time to provide a first degree which will be acceptable to overseas universities as a basis for postgraduate training. Although Khartoum now offers facilities for a postgraduate degree in the agricultural sciences, it is anticipated that a limited number of graduates will wish to undertake postgraduate training and gain overseas experience for some years to come.

In the 1956–57 session the Faculty of Agriculture at Shambat (Fig. 1) has twenty-five students in residence in first year, twelve in second year, and eleven in third year (finals) studying for the degrees of B.Sc. (Agric.) London, B.Sc. (Agric.) Khartoum, and the diploma in agriculture (Khartoum). In 1958 all students in the Faculty will be studying for the B.Sc. (Agric.) or M.Sc. (Agric.) degree of the University of Khartoum. In July 1956 the number of applicants for admission to the Faculty exceeded the intake by 50 per cent. Steps have been taken to remove the limitation due to lack of accommodation since no falling off in the number of applicants is anticipated. Present circumstances thus facilitate the maintenance of entrance standards and ensure a healthy atmosphere of competition.

The Faculty consists of the Departments of Agriculture, Agricultural Biology, Agricultural Chemistry and Pedology, and Agricultural Organization (Rural Sociology), with a sub-department of Agricultural Engineering. Veterinary Hygiene is covered by the staff of the Faculty of Veterinary Science, also situated at Shambat. Facilities are available for postgraduate research and teaching in biochemistry and nutrition, soil science, botany, microbiology, entomology, plant pathology and agricultural engineering (mechanization and irrigation).

Rapid Sudanization of the Agricultural Administrative Service of the Sudan Government has been made possible by the steady flow from Shambat of graduates and diplomates in general agriculture. Most of these posts have now been filled, and although

the requirements of rapidly expanding Government-sponsored development programmes, of private pump irrigation schemes, of training schools and farm institutes have still to be met, the lack of Sudanese specialist research officers is a matter of immediate concern.

It is true that research posts may be filled by science graduates who have had postgraduate training in agriculture, but this training should be given in the Sudan under Sudan conditions. It is hoped that two streams of specialist officers will flow from the Faculty at Shambat: those whose first degree was in pure science and those who have superimposed two years specialist training in one of the agricultural sciences on three years study of general agriculture in the Sudan.

The University Experimental Farm

Sixty acres of demonstration and experimental plots adjacent to the teaching laboratories comprise the Demonstration Farm, the primary function of which is to enable students to acquire practical skill in traditional and improved methods of cultivation. A small area of the Demonstration Farm serves as a botanical museum.

A small herd of 'pure bred' Kenana cattle has been established, and other animals, for example, Nuba mountain dwarf cattle, camels and sheep, are maintained for experimental and demonstration purposes. The inbred line of Kenana cattle will be selected for milk yield, and the results should indicate the improvement which can be achieved in an inbred herd of a single breed by conditions of good feeding and management coupled with selection.

The inadequacy of the area for an agricultural faculty of university status was soon recognized, and, largely as a result of a strong recommendation by Principal D. Skilbeck, of Wye College, London, in 1950, 640 acres were acquired by the Sudan Government and leased to the University in 1952. This land is now being developed as the University Experimental Farm.

When acquired, it was in poor condition. About one-third of the area is saline and in need of reclamation. During the past three years considerable progress has been made towards the eradication of weeds and parasites, especially seid grass (*Cyperus rotundus*) and *Striga hermontheca*, and the restoration of soil fertility. The installation of modern electrical pumping equipment in 1954–55 made possible irrigation of most of the farm land. Farm buildings, cattle pens and a well-equipped dairy were erected in the same period.

About two hundred acres are under crop, and this area is being extended. The principal forage crops grown are berseem (*Medicago sativa*), a legume from which eight 'cuts' of high-quality fodder are obtained annually, dura (*Sorghum vulgare*), maize, wheat, barley, cow peas and haricot beans. Bananas, citrus and vegetables (of European and local origin) are grown as cash crops.

A mixed dairy herd, predominantly of the Butana type, of 130 head has been built up as a result of a long-term selection and breeding programme. The foundation animals of nomadic and northern riverain origin, formerly the Military Dairy Herd of the Ministry of Agriculture, were selected for milk without regard to phenotype and line-bred to two sires since 1944. Milk yields of individual cows have been recorded since 1940. The yield of the herd averages 500 gallons per lactation with 5·7 per cent butter fat. It is now proposed to up-grade this herd by introduction of foreign (Devon) blood by artificial insemination. (A foundation cow, 'Agobe', which had Devon blood was a very high yielder and regular breeder. Her daughters are the best in the herd.)

The main purpose of the University Experimental Farm is that it should serve as the field laboratory of the Faculty. All farming operations are, however, carefully costed separately. It is proposed eventually to set aside an area of about fifty acres to be run as an individual commercial unit representative of Khartoum Province agriculture.

Current research projects are as follows.

Agriculture. (1) Soil reclamation. The following methods are being tested for reclamation of the salty land. On account of the relative scarcity of good farming land in the Northern Province, results of these experiments will have wide application: (*a*) continuous cropping with salt-tolerant crops; (*b*) 'de-salting' by growth and subsequent removal of salt bush (*Atriplex* spp.); (*c*) deep-cultivation (sub-soiling), flooding and removal of saline water by drainage after suitable intervals; (*d*) afforestation as a long-term policy. (2) The establishment of permanent grazing pasture under irrigation. (3) A long-term study of systems of rotation suitable for the Province. (4) Fertilizer and variety trials with wheat and barley. (5) Methods of conservation of grass and fodder crops. (6) A study of the basal metabolism of indigenous cattle. (7) Growth analysis of Fererita dura under different levels of nitrogenous manuring.

Agricultural engineering. Determination of the optimum water requirements of certain crops, for example, berseem, under Shambat conditions, including an examination of the methods of correlating water needs with variations in weather phenomena. The object of this investigation is to find out when to irrigate and how much water to apply.

Agricultural biochemistry and pedology. (1) The effect of continuous cropping of berseem, wheat, lubia (*Dolichos lablab*) and dura on soil and on crop yields. (2) A study of the characteristics and distribution of local soils. (3) Feeding trials of cotton seed meal and hulls, using cattle, sheep and goats. (4) Determination of the nutritive value of dura at different stages of growth. (5) Determination of the composition and chemical structure of the polyuronide gums from *Combretum* and *Entada* species. (6) Determination of the nature and constitution of polysaccharides synthesized by soil micro-organisms in the semi-arid tropics and their value as soil improvers. (7) Determination by feeding trials and analysis of the nutritive value of numerous local fodders and grasses.

Agricultural biology. (1) A study of powdery mildew disease incorporating trials on chemical control of the disease on winter crops in the Northern Province. (2) A study of the feeding habits of hemipterous insects, for example, the cotton aphid and the egg plant tingid bug. (3) Further investigations on the blackarm disease (*Xanthomonas malvacearum*) of cotton in the Sudan, including studies of the mechanism of resistance, strain differences, and the effect of soil conditions. (4) Bacterial diseases of Sudan crops. (5) The examination of insect-resistant varieties of cotton. (6) The suitability of Egyptian varieties of ful masri (*Vicia faba*) for cultivation under Sudan conditions.

THE TRAINING OF MICROBIOLOGISTS

RECENT advances in pure and applied microbiology have been so rapid that it should not be surprising if the teaching of the subject has lagged behind. There is, in fact, a general impression that existing courses are not always adequate and that the extreme variation in content which they show is confusing alike to student and employer. A discussion on the training of microbiologists, arranged jointly by the Microbiology Group of the Society of Chemical Industry and the Society for Applied Bacteriology, was therefore timely. The meeting took place in the Beveridge Hall, Senate House of the University of London, on the afternoon of January 9, with Dr. M. Ingram and Prof. E. L. Crossley sharing the chairmanship.

Three of the principal speakers considered the general content of courses on microbiology. Prof. B. C. J. G. Knight, dealing with "The Academic Basis", pointed out that the early microbiologists had a broad and integrated view of their subject, which was soon lost as their successors became preoccupied with practical applications. Microbiology should still be regarded as a single discipline, since all studies involving small and ubiquitous organisms use similar techniques and since most of the effects produced by such organisms are consequences of the same general property of multiplication. In teaching microbiology, the fundamental unity in biochemistry and physiology underlying the diverse activities of micro-organisms should be emphasized and the biology and physiology of the different groups should be treated on a comparative basis. The course for the B.Sc. degree of the University of Reading is based on these general principles. Dr. G. E. Fogg, speaking on "Algae and the Teaching of Microbiology", mentioned that the syllabus for the M.Sc. degree in microbiology of the University of London, although it allows for some measure of specialization, is likewise based on a broad survey of all aspects of microbial activity. His particular concern was that, at present, courses are almost exclusively confined to the study of bacteria and fungi. In justification of his contention that algae should figure more largely in the teaching of microbiology, he pointed out the contributions which the study of these organisms have made to the development of the subject, their dominant role in natural economy, and their growing economic importance. "The Technological Approach" was considered by Dr. B. H. Arnold, speaking in place of Prof. T. K. Walker. With the growing application of microbiology in industry, more postgraduate courses are needed. These should all start from a sound basis of general microbiology, but specialization in at least three main directions, namely, agricultural, food and chemical microbiology, is necessary. In the field of chemical microbiology the new technology of antibiotic manufacture requires knowledge of chemical engineering and economics. Research may be an important part of the training of an industrial microbiologist, and it is important that this should have some relation to fundamental studies.

More factual accounts of existing courses were given by Dr. M. Woodbine and Mr. A. J. Peters. The former described "The 'Common Stem' Course", as given in the School of Agriculture of the University of Nottingham. Microbiology, which occupies 10 per cent of the teaching time, consists of an elementary introduction covering the classes of bacteria and viruses and the microbiology of water, soil and food, and is given during the first two years of the finals course. This is followed by specialization in subjects such as dairy and food microbiology in the third year. At this stage students must produce a dissertation on some special topic. Mr. Peters's account of "Microbiology Courses in Polytechnics and Technical Colleges" was based on sixty-five replies to a questionnaire sent to ninety-three of the larger colleges. From this it appears that there are few courses which can be classified as 'craft courses'. Most are concerned with training technicians and are related to some particular local industry or activity. Courses of a medical nature predominate in this class, and the others are very varied, being concerned with microbiology as applied in pharmaceutics, baking, catering, sewage disposal, tanning and so forth. Few courses of this type include any general microbiology or even deal with both pathogens and non-pathogens and perhaps the recently instituted endorsed certificate in biology of the Institute of Biology will provide the best general training at this level. Besides those for the external degrees of certain universities, advanced courses exist as for the diploma in biochemical analysis given by the Pharmaceutical Society, and that in metabolism of micro-organisms held at the Chelsea Polytechnic. At a few colleges microbiological research is carried out. The general impression is that classes are usually small and courses sometimes inadequate. Although expansion is taking place, this lacks direction. If microbiology is to develop in technical colleges, it seems that some sort of common course must be introduced and that there must be more encouragement from employers for students to attend the courses.

A third group of papers gave the views of those employing microbiologists. Dr. A. H. Campbell, speaking on "Training required for Microbiologists recruited to the Microbiological Industries", pointed out that successful work in this field is being carried out by people with extremely varied types of training. Of a small sample questioned, fourteen had qualifications in the physical sciences, five were botanists or zoologists, and one had been trained as a bacteriologist; considering those engaged in research only, the corresponding ratio was 7 : 4 : 1 (in the discussion afterwards, the picture presented by this admittedly small sample was confirmed as being a general one). For work on antibiotics it does, in fact, appear that the best training is one in chemistry with the addition of at least a year's study, preferably at the postgraduate-level, of microbiology. Openings are more limited for those whose training is primarily botanical; such people are most useful for specialized work in mycology or physiology of micro-organisms, although it is possible that, with increasing use of antibiotics in agriculture, wider employment for them may be forthcoming. The value of a training in biochemistry for work in industrial microbiology varies greatly according to the school. Mr. T. E. Bashford considered "Training

required for Microbiologists recruited to the Food Industry". The scope for microbiologists in this field has increased considerably in the past ten years, but it is not true to say that there is a large unsatisfied demand for microbiologists. Newly engaged staff lack the necessary specialized knowledge and require a good deal of training. Courses in microbiology should contain more of the processing, preservation and spoilage of foods. Yeasts and moulds are of considerable importance in the industry and should be studied as well as bacteria. Mr. H. Proom, who spoke on "Training required for Technicians in Microbiological Laboratories", said that there is at present a grave need for microbiological technicians. To improve the supply it seems necessary that (1) the work and responsibilities be defined, (2) qualifications must receive general recognition and be correlated with wage scales, and (3) there must be a sufficiently large total number of posts. Industry must give the lead with respect to (1), but work and responsibilities are difficult to define because of the variety of conditions and opportunities. Some of the technician's work is bound to be routine, and no ambitious scheme of training is necessary. Training at this level in industry itself is wasteful, and courses in technical colleges, such as that included in the City and Guilds scheme, seem satisfactory. Training in highly specialized work, electron micrography, for example, is more appropriately given in the course of employment.

From the discussion which followed these papers, it seemed that there was fairly general agreement that the primary object of degree courses in microbiology should be to give a broad training in fundamentals. Of course, indications of practical applications should be given, but it is not for the universities to train for specific industrial outlets. Chemistry is undoubtedly a basic subject for the microbiologist, but the idea that the chemist is just as well able to deal with microbiological processes as the microbiologist was repudiated by many speakers. The biological outlook is essential in industrial microbiology, although it is perhaps true to say that the microbiologist is a specialist whose work is utilized most efficiently if he is supported by a team of chemists. Discussion of the suitability of microbiology as a subject for a first degree was inconclusive. Attention was directed to the fact that microbiology now forms a substantial part of degree courses in pharmacy. For the training of microbiological technicians it was agreed that the City and Guilds scheme meets the need for an elementary non-medical training course. There is clearly room for expansion of courses at this level and there remains a lack of general courses of a more advanced kind for technicians which will perhaps be supplied by those for the advanced level endorsed certificate of the Institute of Biology. Classes cannot be started until a demand exists, but employers are unwilling to send technicians to courses which have not been established. The initiative in breaking this vicious circle must surely come from industry.

G. E. Fogg

OBITUARIES

Sir Arthur Bowley, C.B.E., F.B.A.

Arthur Lyon Bowley died on January 21 at the age of eighty-seven. He was the last of the distinguished statisticians and economists practising at the end of the nineteenth century, and the last of the original group of teachers at the London School of Economics. He will be long remembered, both for his teaching during an active life of fifty years and for his many writings on statistics and on economic and social affairs.

At Trinity College, Cambridge, he was bracketed tenth Wrangler in 1891 and stayed on to gain the Cobden Prize in 1892 with his "A Short Account of England's Foreign Trade in the Nineteenth Century" (published 1893, third edition 1922). Later he obtained the Adam Smith Prize (1894) and the Sc.D. (1913); he was also awarded honorary doctorates by Oxford and Manchester.

For nearly twenty-five years from 1895, Bowley was a part-time teacher of mathematics and statistics at the London School of Economics in the University of London, during a period when statistics was not taught as a separate subject at any other university. He combined this with additional teaching, first as a mathematics master at St. John's School, Leatherhead (1893–99), and then as a lecturer in mathematics and economics at the new University College, Reading (1900–19). It was not until 1919 that he had a full-time teaching post; he was then elected to the new chair of statistics in the University of London, held at the London School of Economics. He retired from this chair in 1936, being made professor emeritus in the University. Afterwards he was called upon to act as director of the Oxford University Institute of Statistics for a war-time period (1940–44).

As a teacher, Bowley was a meticulous expositor and an inspiration to the inquiring mind; but he made few concessions to the weaker students. His influence was greater among postgraduate than undergraduate students, and greater still with mature research workers. Both Lord Stamp in his work on British incomes and property and Lord Beveridge in his Social Insurance Report were greatly indebted to Bowley for technical advice.

He contributed to the advancement of statistical and economic theory, which he translated into his own mathematical terms. But his more important and lasting work was in the application of statistics to economic and social problems. It can be said that recent developments in such fields as market research arose from his pioneering work, from 1910 onwards, on the use of sampling techniques in social surveys. Equally, practitioners of the art of interpreting current economic movements owe a good deal to his work for the London and Cambridge Economic Service, of which he was editor from the beginning in 1923 until 1945.

His advice was much sought after, both in Great Britain and abroad. He was for many years a member of official committees concerned with the cost of living and related matters. He was active in the affairs of the British Association, holding office

in Section F from 1899 until 1911. The Royal Statistical Society, of which he was a Council member as early as 1898, awarded him the Guy Medal (Gold) in 1935 and elected him president during 1938–40. The International Statistical Institute called upon him on numerous occasions; he wrote several of the Institute's reports, and he served as treasurer and bureau member during 1929–36 and again from 1947 until 1949. The statistical work of the League of Nations in the early years was furthered by two reports commissioned from him. With Sir Dennis Robertson he visited India in 1934 to prepare a scheme for an economic census. He was created C.B.E. in 1937 and made a knight bachelor in 1950; he was elected a Fellow of the British Academy in 1922.

Bowley was the author of more than twenty books and pamphlets, in addition to numerous articles, reports and memoranda. Some of them are of continuing value, particularly his "Wages and Income in the United Kingdom since 1860" (published 1937), in which he brings together much of the work on wages he undertook from 1895 onwards. Two of his text-books are still used quite widely: "An Elementary Manual of Statistics" (seventh edition, 1951) and "Elements of Statistics" (second impression of sixth edition, 1946).

In the nature of things, Bowley is survived by few of his contemporaries; but he will be missed by all those who knew him and so came to appreciate his incisive mind, his liberal outlook and his dry sense of humour. R. G. D. ALLEN

Dr. F. A. Henson

DR. FREDERICK ARTHUR HENSON, lecturer in the Department of Geology, University of Nottingham, died suddenly on January 14. Born at Wolverton, Bucks, on June 30, 1919, he proceeded to the University of Reading in 1937. During 1940–45 he was on active service, first as a fighter pilot in the Fleet Air Arm and later as staff meteorological officer on the personal staffs of Admiral Somerville and Admiral Mountbatten in the South-East Asia Command. Resuming his studies after distinguished war-time services, he completed his degree course and proceeded to research work in the University of Reading on the geology of the Channel Islands, for which he was awarded the degree of Ph.D. of his University.

In 1947 Dr. Henson was appointed lecturer in the University of Nottingham and developed courses in petrology and economic geology. His work on the Channel Islands continued, and a series of important papers, some of which are still in manuscript, have emerged on the granites and the migration of trace elements associated with granitization in Jersey. During the past three years he stimulated researches on the basalts and associated rocks of Iceland, and with enormous energy and enthusiasm made two expeditions to study these rocks. At the peak of his career it seems so tragic that the results of this important field of research had just reached the stage of publication.

His writings covered a wide variety of topics; and he was also responsible for the teaching and development of a complete university course of study in photogrammetry. He was an active member of the Board of the Faculty of Pure Science in the University of Nottingham, the University representative on the Outward Bound Trust and a lieutenant-commander in the R.N.V.R. His stimulus and influence on all sections of University life will be a great loss, and his ever-ready help to expeditionary projects will be sadly missed by the undergraduates of the Universities of Nottingham and Reading. W. D. EVANS

NEWS and VIEWS

Physics at the Imperial College: Dr. C. C. Butler

DR. C. C. BUTLER has been appointed to the chair in physics tenable at the Imperial College of Science and Technology, London, left vacant when Prof. S. Devons was appointed to the University of Manchester in 1955. Dr. Butler, who was born in 1922, graduated at the University of Reading in 1942. His first postgraduate work was with T. B. Rymer at Reading on precision measurements in electron diffraction. In 1945 he became assistant lecturer in physics in the University of Manchester and lecturer in 1947. When Prof. P. M. S. Blackett moved to the Imperial College in 1953, Dr. Butler was appointed reader in the University of London, and since 1955 he has been assistant director of the physical laboratories at the Imperial College. During 1946–47 in Manchester, Dr. Butler, in collaboration with Dr. G. D. Rochester (now professor of physics in the Durham Colleges in the University of Durham), discovered the charged and neutral V-particles, using a counter-controlled cloud chamber in a magnetic field. In 1956 the Physical Society awarded them jointly the Charles Vernon Boys Prize for this work. In 1951 Dr. Butler moved this apparatus to the Pic-du-Midi laboratory in the Pyrenees and has directed the work of the group running it ever since. Very soon after the work started in the mountains, the negative cascade hyperon was discovered and the neutral V-particle transforming into a proton and a meson was first identified.

Ministry of Supply: Chemical Defence Research: Mr. A. E. Childs, C.B.E.

ON January 16, after thirty-six years continuous service in the field of chemical defence research, Mr. A. E. Childs retired from the headquarters post of director of chemical defence research and development in the Ministry of Supply. He graduated at the University of Cambridge in 1920 and later at the University of London. During the First World War he held appointments as divisional gas officer and general staff officer (3) with the British Expeditionary Force in France. In 1921 he joined the staff of the Chemical Warfare Research Station, Porton, where his resourceful and energetic disposition found ample scope. Later, he held senior posts in the chemical and research divisions of the Establishment. During the Second World War his activities included a mission to chemical warfare establishments in the Commonwealth countries and the United States, and in 1943 he was appointed principal technical adviser to Mr. Davidson Pratt, the controller of research and development in the chemical warfare field. At the end of the War Mr. Childs became leader of the

British team which investigated German chemical warfare research. Following the post-war reorganization of the Ministry of Supply, he was appointed in 1949 director of chemical defence research and development, and his long experience and intimate knowledge of chemical defence gained him an international reputation in this field.

Mr. E. E. Haddon

Mr. E. E. Haddon, whose promotion to deputy chief scientific officer and appointment as director of chemical defence research and development at the age of forty-eight was recently announced by the Ministry of Supply, was educated at Archbishop Holgates Grammar School, York, and at the University of London, where he graduated with honours in chemistry in 1929. In that year he entered government service as a research assistant in the then Chemical Warfare Research Department of the War Office. He was transferred to the Ministry of Supply on its creation in 1938 and throughout the War served on the headquarters staff of the Controller of Chemical Defence Research and Development. In 1943, Mr. Haddon was elected a Fellow of the Royal Institute of Chemistry and in 1945 was promoted to senior principal scientific officer to take charge of the secretariat to the Ministry of Supply Scientific Advisory Council and its Technical Information Bureau. He returned to the Chemical Defence Branch as assistant director in 1952.

National Institute for Research in Nuclear Science

In the House of Commons on February 14, the Financial Secretary to the Treasury announced in a written answer that, after consultation between the University Grants Committee, the Atomic Energy Authority and the Departments concerned, the Government has decided to set up a National Institute for Research in Nuclear Science. The main object of the Institute will be to provide, for common use by universities and others, facilities and equipment which are beyond the scope of individual universities and institutions carrying out research in the nuclear field. It will not replace the research now proceeding in individual universities with assistance from Government funds, nor affect the Government's participation in the international scheme for common facilities in Geneva. It is proposed to finance the Institution in the main by grants through the Atomic Energy Authority from the Lord President's Atomic Energy Vote, and provision will be made in the Estimates accordingly. Expenditure by universities will be limited to payment of the salaries and expenses of their own academic staff utilizing the research facilities provided by the Institute. The Institute will be managed by a governing board appointed jointly by the Lord President of the Council and the Chancellor of the Exchequer, and consisting of representatives of the universities, the Atomic Energy Authority, the University Grants Committee, the Royal Society and the Department of Scientific and Industrial Research, with an independent chairman; Lord Bridges has accepted appointment as chairman.

Scientific and Industrial Research Co-operation in the Commonwealth

In reply to a question in the House of Commons on January 29, the President of the Board of Trade said that the National Research Development Corporation, which has the statutory function of developing and exploiting British inventions, is ready at all times, if requested, to give bodies having similar objectives in Commonwealth countries the benefit of its experience. The British Productivity Council is also always willing to share its experience with other Commonwealth countries, but it would be outside its province to undertake work in British countries overseas. The Department of Scientific and Industrial Research maintains close co-operation with Commonwealth countries mainly through the agency of the British Commonwealth Scientific Offices; and as well as through the individual scientific liaison officers maintained by Commonwealth countries in the United Kingdom, there is direct collaboration between corresponding research establishments of the Department and Commonwealth Governments. The resources of the Department, which is represented on the Colonial Research Council, are available to Colonial Territories and there are Colonial research liaison officers at several of the Department's research establishments. The British Standards Institution also has wide contacts with Commonwealth and other countries on standardization questions, while the Colonial Development Corporation is able to draw on the advice and experience of the Department of Scientific and Industrial Research, the National Research Development Corporation and the British Productivity Council as and when required, without the need for formal liaison. Subject to Parliamentary approval and to satisfactory arrangements under discussion for the future financing of the Agency, the Government has offered to contribute up to £150,000 per annum to the cost of continuing the European Productivity Agency for a further three years from July 1, 1957.

Research Collaboration between Britain and the Organization for European Economic Co-operation

The question of research projects being carried out by the Department of Scientific and Industrial Research in co-operation with the Organization for European Economic Co-operation was raised in the House of Commons; on February 12, Mr. H. Nicholls, Parliamentary Secretary to the Ministry of Works, speaking for the Lord President of the Council, said that the Department is in direct collaboration with the European Productivity Agency of the Organization on five projects connected with aspects of building practice and in the preparation of material for conferences on automation and adaptation of the job to the worker. It is also collaborating with seven other countries in a research project on the preparation of fresh water from salt water. The five building projects were: modular co-ordination; pre-fabrication in house building; methods of organization on building sites; mechanization of certain building operations; and production and distribution of concrete on building sites. The Lord President agrees that this form of co-operation should be encouraged as one of the most effective forms of European co-operation.

British Expenditure on Scientific Research and Development

Replying to Mr. Braine in the House of Commons on February 14, the Financial Secretary to the Treasury, Mr. J. E. Powell, said that the proportion of the gross national production spent on scientific research and development, excluding market research

and capital development, was estimated at about 2 per cent in 1955. Between one-third and one-half of this work was done in Government laboratories and nationalized industries, and much of the remainder was financed by the Government. There were no estimates for 1939 and 1950. The Advisory Council on Scientific Policy is considering the whole question of the extent to which Britain's resources are devoted to research, and the results of this investigation will be issued in due course.

Emigration of British Professional Men

THE Under-Secretary of State for Commonwealth Affairs, replying to a question in the House of Commons on February 14, gave the numbers of Commonwealth citizens with professional qualifications who have left the United Kingdom direct by sea to reside for more than one year in countries outside Europe during the years 1953–55 and the first half of 1956 as follows: 1953, 7,730; 1954, 6,906; 1955, 6,228; 1956, 2,804. The proportions to total emigrants of working age were 7·6 per cent, 7·3 per cent, 7·6 per cent, and 5·6 per cent, respectively. Of the total for the first six months of 1956, 808 were teachers, 116 had legal qualifications, 38 medical, 710 professional engineering and 790 other professional qualifications. The corresponding figures for the three previous years are: 1953 (2,882, 236, 984, 1,802 and 1,826); 1954 (2,684, 190, 972, 1,344 and 1,716); 1955 (2,552, 158, 876, 1,104 and 1,540).

The Siting of Power Stations

REPLYING to questions in the House of Lords on January 29 as to the authority deciding the location of nuclear power stations and the grounds on which such decisions are based, Lord Mills said that the Central Electricity Authority was responsible for selecting the sites in England and Wales for electric power stations. The most important criteria, which are set forth in the Authority's Annual Report for the year ended March 31, 1956, are large and readily available supplies of water for cooling purposes and ground formation capable of bearing the extremely heavy reactors. Before proceeding with the construction of nuclear power stations on the selected sites the consent of the Minister of Power was required and also planning permission under Section 35 of the Town and Country Planning Act, 1947. Pressed by Lord Lawson and Lord Lucas of Chilworth as to public disquiet, Lord Mills agreed that the Minister should make all proper inquiries to enable him to make a right and wise decision. He agreed that there were many criteria to be considered and that he would be lacking in his duty if he did not take into account any disquiet there might be on this subject. There were many more nuclear power stations to be built and he was impressed with the importance of preserving the amenities of the countryside, as far as possible, in developing those plans. He also promised to bear in mind Lord Alexander of Hillsborough's request for improvement in the judicial character of any inquiries.

Designation of Quantock Hills

THE first part of England to be established as "an area of outstanding natural beauty" is the Quantock Hills, Somerset. Like the Gower Peninsula in Wales, it is the subject of an order made by the National Parks Commission under the National Parks and Access to the Countryside Act, 1949, and confirmed by the Minister of Housing and Local Government. The effect of the order is to place upon the local planning authority, Somerset County Council, the special responsibility of preserving and enhancing the natural beauty of the landscape. The Quantock Hills stretch from Bridgwater Bay, in the Bristol Channel, south-eastwards towards Taunton. There are thirty-eight square miles of sandstone hills, rising to a height of 1,261 ft. above Crowcombe, with smooth downs, wooded combes, picturesque villages, fine manor houses and farmlands, rich in folk-lore and literary associations. Government grants at the rate of 75 per cent are available towards the cost of treating derelict land, tree planting and preservation, and removing disfigurements. Grants are also available towards expenditure incurred in making agreements with landowners for public access to open country, and in appointing wardens. Designation does not of itself provide any additional right of access to private land.

Scientific World

THE first issue of the *Scientific World*, published by the World Federation of Scientific Workers, includes contributions from the United States, the Soviet Union, England, Brazil, Czechoslovakia and India on such varied topics as automation, the training of Soviet research workers, the Bessemer centenary, the present position of research and scientific workers in Brazil, India's fuel prospects and contacts between Soviet and American microbiologists. A communication from Czechoslovakia on common problems of scientists elaborates more fully what the editorial board hopes to achieve through the new periodical in presenting a balanced reflexion of the thought of scientists throughout the world on the social relations of science, the conditions best promoting the healthy growth of science and the application of its results for human welfare, with the aim of expanding co-operation in the constructive application of science. In particular, it is hoped to promote the international expression of the views of individual scientists and to assist in disseminating knowledge of the progress of the special agencies of the United Nations.

The Institute of Biology

THE Institute of Biology has elected Prof. W. H. Pearsall as its president for 1957. Prof. Pearsall played a leading part in the foundation of the Institute and has taken an active interest in promoting its growth to the present membership of 1,300 full members, 90 associate members and 280 student members. Mr. H. J. Bunker has succeeded Dr. G. E. Fogg as the Institute's honorary secretary and brings to the office the experience of seven years service on the Council of the Institute. The *Journal of the Institute of Biology*, which contains articles of general biological interest, comment on those matters which affect the professional interests of biologists, book reviews and news of matters biological, is now available to the public at a price of 10*s.* 6*d.* per volume of four quarterly parts. Jointly with the Biological Council, the Institute of Biology has published a "Diary of Meetings of Biological Societies, 1957", copies of which are now available. During 1957, in addition to meetings of branches, the Institute is arranging a discussion on "The Nutrition of Parasites", a meeting on the professional problems met by biologists working in the Colonies and a two-day symposium on "The Biological Productivity of Britain". Further information can be obtained from the General

Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

Committee to Review Radiological Practice

A Committee has been set up by the Minister of Health and the Secretary of State for Scotland: "To review the present practice in diagnostic radiology and the use of radiotherapy in non-malignant conditions, having regard to the Report of the Committee on the Hazards to Man of Nuclear and Allied Radiations and to make recommendations". The members of the Committee are: *Chairman*, Lord Adrian, Master of Trinity College, Cambridge; *Members*, Prof. J. C. McC. Browne, professor of obstetrics and gynæcology, University of London (Hammersmith Hospital); Sir Horace Evans, director, Medical Unit, London Hospital; R. J. G. Grewcock, dental surgeon; Prof. R. J. Kellar, professor of obstetrics and gynæcology, Edinburgh; Peter Kerley, director, X-ray Unit, Westminster Hospital; D. R. Maitland, radiologist, Royal Infirmary, Edinburgh; Prof. W. V. Mayneord, professor of medical physics, University of London (Royal Marsden Hospital); Prof. J. S. Mitchell, professor of radiotherapeutics, Cambridge; C. Naunton Morgan, consultant surgeon, St. Bartholomew's Hospital; Kenneth Robson, chest physician to St. George's Hospital and Brompton Hospital; T. Holmes Sellors, thoracic surgeon, Middlesex Hospital, and senior surgeon, London Chest Hospital; G. R. Seward, dental surgeon; Prof. F. W. Spiers, professor of medical physics, Leeds; Prof. E. J. Wayne, regius professor of the practice of medicine, Glasgow; Prof. C. A. Wells, professor of surgery, Liverpool; Prof. B. W. Windeyer, professor of radiotherapy, University of London (Middlesex Hospital).

New Seismological Equipment at British Observatories

At the University of Durham Observatory, an underground chamber has been excavated which can be maintained at a constant temperature. In this chamber there have been installed the two horizontal component Milne–Shaw seismographs which the Observatory already had, and in addition a Wilson–Lamison vertical seismometer, galvanometer and recorder. It is intended to keep all three seismographs in constant operation. Mr. E. F. Baxter is in charge of the seismological observatory.

At the Department of Geodesy and Geophysics, Madingley Rise, University of Cambridge, the underground laboratory originally planned for construction under the grant from the Crombie Bequest to the British Association Committee for Seismological Investigations is now being built on a much larger scale. It is hoped that by April three Benioff seismographs of one-second period will be installed in the Crombie Vault. In addition, two Hill seismographs of specially long period, recording the horizontal components of ground motion, will be working in order to make a special study of the long period phase of teleseisms. The Cambridge laboratory will be maintained on an experimental basis rather than as an observatory for purely routine observations.

Lady Tata Memorial Trust Scholarships and Fellowships

The Trustees of the Lady Tata Memorial Fund invite applications for grants, scholarships or fellowships for research on diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1, 1957. In view of the affinity between leukæmia and other forms of neoplastic disease, candidates with programmes of research on any aspect of malignant disease which may throw light on problems of leukæmia will be eligible for consideration. Grants of variable amount are made for research expenses or to provide scientific or technical assistants for senior workers. Scholarships are awarded for the personal remuneration of workers carrying out approved research under suitable direction; their normal value will be £600 per annum. In addition, the Trustees may award one or more Lady Tata Memorial Research Fellowships to workers with considerable research experience, with stipends of £1,200 per annum. Further particulars and forms of application may be obtained from the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, Chester Beatty Research Institute, Fulham Road, London, S.W.3. Applications must be submitted before March 31, and the awards will be announced by the Trustees in June. The grants, scholarships and fellowships offered by the Trust are open to suitably qualified investigators of any nationality, working in any country in which it will be possible to make payments in the coming academic year.

French Government Exchange Scholarships in Medical Science

Under the terms of a reciprocal arrangement with the Centre National de la Recherche Scientifique, the Medical Research Council invites applications from British workers in medical science for two scholarships tenable at research institutions in France during the academic year 1957–58. Candidates must be of British nationality and have at least a working knowledge of French. The scholarships will normally carry a maintenance allowance within the range 50,000–70,000 francs per month. A marriage allowance and travelling expenses will also be granted where appropriate. Forms of application may be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, with whom applications must be lodged by March 31.

Comet Arend-Roland

A new comet was discovered by Arend and Roland at the Royal Observatory of Belgium, Uccle, on November 8, 1956. It was of the tenth magnitude at discovery; by the beginning of February 1957 it had brightened to magnitude 8 and had developed a tail at least half a degree long. Numerous observations of position have been made and several sets of elements for the orbit computed. Conditions in March are not favourable for observation, as the comet will be too close to the Sun. During the first half of April the comet will be very well placed for observers in the southern hemisphere; it is expected to be a fine bright object, possibly of zero magnitude, visible shortly before dawn. During the third week of April the comet passes between the Earth and the Sun and moves rapidly northwards. It will be visible from the British Isles at the end of April and in May, by which time it will have become a circumpolar object visible throughout the night. It is difficult to give a reliable prediction of the brightness of a comet, but it seems probable that it will be about magnitude 2 at the beginning of May and magnitude 6 by the end of May. If the predictions are fulfilled, the comet will be one of the brightest of

the century, and will offer an excellent opportunity for astrophysical studies with large telescopes. The behaviour of the comet is quite similar to that of Comet Brooks 1911. The latter became a naked-eye object with a long tail. Comet Arend–Roland will be even closer to the Sun at perihelion than was Comet Brooks, and the present comet is already brighter than Comet Brooks was at the same heliocentric distance. There would thus seem every prospect of a magnificent display by Comet Arend–Roland.

The Night Sky in March

New moon occurs on Mar. 1d. 16h. 12m. U.T., full moon on Mar. 16d. 02h. 22m., and new moon on Mar. 31d. 09h. 19m. The following conjunctions with the Moon take place: Mar. 7d. 13h., Mars 1° N.; Mar. 16d. 09h., Jupiter 6° N.; Mar. 21d. 18h., Saturn 0·2° S. Mercury and Venus are too close to the Sun for observation. Mars sets at 0h. 10m., 0h. 05m. and 0h. 00m. on March 1, 15 and 31, respectively; its stellar magnitude decreases during the month from + 1·2 to + 1·6 and its distance from the Earth increases from 149 to 175 million miles. Mars is in Aries at the beginning of the month, entering Taurus on March 8. It is south of the Pleiades on March 14. Jupiter rises at 19h. 20m., 18h. 10m. and 16h. 50m. at the beginning, middle and end of the month, respectively, and is visible throughout the night; its stellar magnitude is − 2·0, its distance in the middle of the month is 415 million miles. Jupiter continues to retrograde; it is near β Virginis. Saturn rises at 2h. 10m., 1h. 15m. and 0h. 15m. on March 1, 15 and 31, respectively, and its stellar magnitude is + 0·7; it is in Ophiuchus, being stationary on March 24, and afterwards moving westwards. Its distance from the Earth on March 15 is 910 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: March 13d. 18h. 22·6m., ω Leo. m. (*D*); March 23d. 5h. 04·3m., μ Sgr. (*D*). *D* refers to disappearance. The vernal equinox occurs on Mar. 20d. 21h.

Announcements

The Admiralty has announced the creation of a new post of Rear-Admiral Nuclear Propulsion to be filled by Rear-Admiral G. A. M. Wilson, who will be responsible to the Engineer-in-Chief of the Fleet. He will act as the focus within the Admiralty of the operational and material aspects of nuclear propulsion, and will keep in touch with developments by the Atomic Energy Authority and by industry in the application to ships of nuclear power.

Dr. Richard Wilson has been appointed associate professor of physics in Harvard University from July 1. A native of London, Dr. Wilson graduated at Christ Church, Oxford, in 1946 and received the degrees of M.A. and D.Phil. in 1949. He taught and conducted research in the field of high-energy nuclear physics at the Universities of Oxford, Rochester and Stanford before going to Harvard as assistant professor in 1955.

Mr. E. J. Perkins, of the Department of Natural History, Bell Pettigrew Museum, The University, St. Andrews, Fife, is collecting material for a monograph on British free-living marine Protozoa, but, apart from a few groups, records are scanty and difficult of access. He would be glad to hear from any reader possessing records of these forms either unpublished or printed in works of limited distribution.

The Institution of British Agricultural Engineers offers three scholarships for award to candidates eligible for entry to the year's course of study leading to the National Diploma in Agricultural Engineering, namely, the Dunlop Rubber Company Scholarship (value £250), the "Farm Mechanization" Scholarship (Temple Press, Ltd.) (value £100), and the Shell-Mex and British Petroleum Scholarship (value £250). Applications should be sent (before May 1) to the Secretary of the Institution of British Agricultural Engineers, 6 Buckingham Gate, London, S.W.1, to whom all inquiries should be addressed.

The Photoelectric Spectrometry Group is to meet on March 29 at 2.30 p.m. in the Physical Chemistry Department, Cambridge, to discuss "The Uses of Spectrophotometers in Kinetic Studies". Further details will be available later from Mr. K. A. Macdonald, Unicam Instruments, Ltd., Arbury Works, Cambridge.

On the occasion of its fifth annual meeting the Editorial Board of the *Journal of Embryology and Experimental Morphology* is sponsoring an International Embryological Conference to which all interested scientists are invited. The Conference will be held in the Department of Anatomy, University of Cambridge, during April 10–13. Attendance is free and open to all on application to Prof. J. D. Boyd, Anatomy School, Cambridge.

The inaugural meeting of the Plant Phenolics Group is to be held in the Botany School, Cambridge, at 11 a.m. on April 9, when a number of papers will be presented under the general heading "Oxidation of Plant Phenolics". Membership of the Group is open to all chemists and biologists interested in the phenolic constituents of plants, without fee. Further details may be obtained from Dr. E. C. Bate-Smith, Low Temperature Research Station, Downing Street, Cambridge.

The second Colloque International sur la Qualité Végétale, sponsored by the Association Internationale de Recherches sur la Qualité des Plantes Alimentaires, is to be held in Paris at the Conservatoire National des Arts et Métiers during April 24–27. It will be devoted mainly to discussing the origin and distribution of amino-acids, of vitamins and of non-tetrapyrrolic pigments in edible plants. Further information can be obtained from the general secretary, Prof. L. Genevois, Faculté des Sciences, Université de Bordeaux, 20 cours Pasteur, Bordeaux.

Prof. W. Süss, of the University of Freiburg in Breisgau, Hebelstr. 40, has announced the following colloquia, to be held at the Mathematical Research Institute at Oberwolfach in the Black Forest. Applications to attend are requested as soon as possible. March 11–16, "Number Theory" (under Prof. H. Rohrbach, of Mainz, and Prof. Th. Schneider, of Erlangen); March 18–22, "Function Theory in Several Variables" (under Prof. H. Behnke, of Münster, and Prof. K. Stein, of Munich); April 10–14, "History of Mathematics, with Special Reference to Euler, born April 15, 1707" (under Prof. J. E. Hofmann, of Tübingen). Eight similar conferences were held during 1956, at which attendances varied from fifteen to forty.

Erratum. In the communication entitled "Differential Insecticide Damage in Maize Varieties", in *Nature* of January 12, p. 109, line 2, for "carbon disulphide" read "carbon tetrachloride".

NATURE CONSERVANCY

REPORT FOR 1955–56

DURING the year ended September 30, 1956, covered by its seventh annual report*, the Nature Conservancy was able to pursue its research and development programme without serious distraction, and the level of grant-in-aid has been increased from £202,000 in 1954–55 and £203,400 in 1955–56 to £280,000 in 1956–57. While this increase is insufficient to enable the Commission to overtake the accumulation of several years arrears, it allows the worst consequences of earlier financial stringencies to be corrected, although scientific programmes had again to be restricted and work on the development and maintenance of reserves postponed. The internal organization has been overhauled so as to strengthen the Conservation Branch as the central executive organ for the future and enable it to cope with the increasing load of advisory and liaison activities and of reserve management and the related experimental work.

Besides the accounts, which record a general expenditure of £186,587 and capital expenditure of £19,035, appendixes include a list of committees and their terms of reference and membership, as well as lists of establishments of the Conservancy and of research grants during the year. Tribute is paid in the report to the great services of Sir Arthur Tansley, which the Conservancy proposed to commemorate by placing a suitably inscribed sarsen stone by the great yew grove at Kingley Vale Nature Reserve. To strengthen the Conservancy's link with the work of the scientific staff and the fulfilment of their programme, the Scientific Policy Committee created a Panel of Visitors which spent several days at the research stations, discussing progress and problems with the scientific staff. This detailed review has confirmed both the soundness of the scientific programme and the competence of the scientific officers to execute it.

In scientific research the year was one of consolidation and progress within existing programmes. At the Moor House Nature Reserve a number of species of plants from the Lake District and from Scotland have been planted in the sheep enclosures at the western end of the Reserve in an attempt to re-create the types of plant community which may have existed before the introduction of intensive grazing. Data for two full years obtained from the weirs, installed to measure run-off for catchment areas covered with peat, indicate that after heavy rainfall the peak flow from the catchment area covered by natural sphagnum bog is less and occurs later than that from an area of which parts have been burned, surface-drained or eroded. In studies on peat and peat vegetation, attention is being directed to aspects of fertility and nutrient turnover, with special reference to the role of phosphorus as a possible limiting factor. From investigations on the grasslands and soils of Snowdonia it appears that those derived from volcanic ashes are the most subject to erosion, but they bear the better kinds of mountain grass and carry the greater number of sheep per acre.

At Benin Eighe, experiments have continued on the fundamental aspects of pine-wood ecology, and in the Cairngorms investigations are in progress into factors affecting the natural regeneration and persistence of the Scots pines, while the experiments at Moor House on the re-establishment of high-level woodland continue to yield interesting results. Work at Merlewood is concerned with the behaviour of woodland as a whole in relation to soil fertility, water balance and biological productivity, and also with the detailed ecology of individual woodlands. Similar intensive studies are being carried out in the Roudsea Wood Nature Reserve, including the study of natural regeneration; and in view of the severe damage in the oak wood from attacks of *Tortrix viridana* caterpillars, future investigations will be aimed at developing control measures suitable for use in nature reserves, where, if insecticides are to be used, a high specificity and short residual action are desirable to avoid excessive damage to the insect fauna as a whole.

Studies on litter breakdown and the associated fauna of both soil and litter continued at Merlewood, and at Roudsea Wood field experiments have been set up to determine the rate of disappearance of the various types of leaves on the different soil types, while intensive laboratory studies have been made on the estimation of amino-acid contents in extracts of fallen leaves and on extracting the nematodes. A statistical procedure used to investigate the composition of the soil fauna in relation to different kinds of woodland yielded results suggesting that a characteristic fauna has developed in association with the native broadleaved woodlands, whereas the coniferous woodlands have as yet only the general woodland fauna. Research continued in the Forestry Commission's plantations in the Carron valley, Stirlingshire, on the part voles play as consumers of the grasses of upland areas, and investigations are being maintained into the repercussions on vegetation and animal life of the reduction in rabbit numbers.

In coastal research at Bridgwater Bay new evidence was obtained that cord grass (*Spartina townsendii*) virtually arrests the movement of shingle, and the controlled sheep-grazing experiments on *Spartina townsendii* marsh suggest that a properly managed grazing regime favours the development of a fine marsh turf valuable as a feeding ground for stock and wildfowl. Experiments in co-operation with the Isotope Division of the United Kingdom Atomic Energy Research Establishment and the Department of Geography, University of Cambridge, have demonstrated the possibility of using radioactive isotopes to trace the movement of coarse beach material in the offshore zone at Scolt Head Island. Measurements of the dune vegetation on transects extending half a mile at Newborough Warren, Anglesey, have shown that, since the loss of rabbits through myxomatosis, the taller and more drought-tolerant species have increased at the expense of the shorter and

*Report of the Nature Conservancy for the year ended 30th September, 1956. Pp. v+82+12 plates. (London: H.M. Stationery Office, 1956.) 4s. 6d. net.

less drought-tolerant species. Some progress was made in preparing a full account of the first three years general climatological observations at Moor House, and this chapter of the report includes a list of scientific publications during the year.

The report contains a new section dealing with scientific advisory services, which have increased greatly and are expected to expand further. Advice on land use was given to the Royal Commission on Common Land and a programme for short-term research on grey seals in relation to salmon fisheries has been initiated after discussions between the Conservancy, the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department. The scientific staff have investigated the vegetation of the reindeer reserve in relation to the feeding habits of the herd, and are to study in more detail the effects of the grazing of reindeer on the mountain pastures, particularly the rate of re-growth of lichens on the grazed areas. The final assessment of plots sprayed with selective weed-killers for four consecutive years indicates that the use of selective weed-killers for blanket spraying on this type of community is of limited value in improving visibility for road users, but that they could be used against obnoxious weeds which occur in localized strands, for example, *Cirsium* and *Rumex* species, and for clearing scrub. Following an initial discussion in September 1955, the Nature Conservancy is to call a meeting of those engaged in ecological research touching any aspect of moor burning. The Conservancy is also concerned about the harmful effects which uncontrolled and unessential burning may inflict on both the flora and fauna and on soil fertility and is investigating the development of an effective alternative method of controlling unwanted woody vegetation which will not cause indirect damage to other plant and animal life.

The rate of acquisition of new national nature reserves continued to fall below what was hoped, but the twelve new reserves established during the year and additions to four existing reserves brought the total to 47 reserves and 82,662 acres, compared with 35 reserves and 79,035 acres on September 30, 1955, of which little more than one-third is owned by the Conservancy. Following notification of local planning authorities of sites of special scientific interest under Section 23 of the Act in England and Wales, seventeen counties in Scotland have now been covered, the fifty-eight sites notified involving an approach to ninety-seven different owners. Despite the publicity given by voluntary societies, much remains to be done to secure observance of the general principle of the Protection of Birds Act, 1954, and the Conservancy has advanced proposals for the creation of a number of sanctuaries under the Act. A brief report is included on the Humber Wildfowl Refuge, the first sanctuary in which public access has been legally regulated in the interests of the wildfowl. The statement regarding the buzzard issued to the press in March 1956 is also included, the facts in which have since been largely confirmed by the 1956 Buzzard Survey.

Only seven new grants, amounting to £11,000, were awarded during the year and no new applications can be considered before September 1957, to take effect in 1958–59. Excellent progress was made with the National Collection of Nature Photographs, which now includes some two hundred photographs.

NATIONAL PARKS COMMISSION

REPORT FOR 1955–56

THE seventh annual report of the National Parks Commission*, covering the year ended September 30, 1956, records no designations of new National Parks, although the Order for the Northumberland National Park was confirmed, with slight modification. The Minister's decision on proposals for the Brecon Beacons National Park is still awaited, and the Commission has now reached the conclusion that designation of the South Downs as a 'park' would not be appropriate and it is instead considering its designation as an area of outstanding beauty. The Ministry of Housing and Local Government was not prepared to support the Commission's request for implementation of the proposals drawn up by the Nature Conservancy for an immediate scientific study of the ecological and other factors underlying the problem of preserving the Broads from encroachment.

The report shows that the Commission continues to be deeply concerned as to the adequacy of the arrangements for the administration of the parks and the failure of the Minister to implement the Act. In spite of the Commission's advice that there were no special circumstances in the Yorkshire Dales warranting departure from the form of administration laid down by Parliament as appropriate for multi-county national parks, the Minister has issued a direction under the Act dispensing with the formation of a Joint Board for the Yorkshire Dales National Park. The administrative arrangements for Snowdonia, made in 1953 for an experimental period of three years, have been extended for a further three years, though without objection from the Commission; and for reasons the opposite of those given in the case of the Yorkshire Dales, the Minister has also, in accordance with the wishes of the Devon and Somerset County Councils, issued a direction under the Act dispensing with the formation of a joint board for the Exmoor National Park in place of a joint advisory committee. The dubiety of these alternative arrangements is sufficiently illustrated by the Lake District Planning Board's approval, in the face of urgent protests from the National Parks Commission and amenity societies, of a scheme for more than a mile of overhead electricity cable at the head of Great Langdale. The National Parks Commission, in correspondence appended to the report, maintains the view it has consistently expressed that Great Langdale is one of the places of outstanding scenic quality where the whole of the line ought to be laid underground and that the relatively small cost of doing so should be borne by the national undertaking. The Lake District Planning Board, however, has risen to the bait offered by the Electricity Board in the form of a promise of earlier supply if overhead cables were used.

Apart from the concern over such matters and over the large number of aerial masts which are being erected in the countryside for both civilian and military purposes, the Commission has given increased attention to the designation of areas of outstanding natural beauty under Section 87 of the Act. Areas have been designated in the Gower Peninsula, in the Quantocks, in Lleyn and in the Surrey Hills, which

* Seventh Report of the National Parks Commission for the year ending 30th September, 1956. Pp. iv+66+8 plates. (London: H.M. Stationery Office, 1956.) 4s. net.

now await the Minister's confirmation, and formal proposals have been made to the county councils for the designation of sections of the coast of north and south Cornwall and of Dorset. The Commission proposes to add each year some half a dozen areas to the list of those enjoying the special protection which it is the object of the Act to afford. The Commission has also secured the part-time services of Sir Geoffrey Stuart to help local authorities in the creation of footpath agreements, thus reducing the time between approval by the Minister of a report by the Commission on a long-distance route and the completion of that route. The Commission's proposals for the Offa's Dyke route were approved during the year and the difficulty over the alternative bad-weather section of the Pennine Way in Colne Valley Urban District has been resolved.

The Commission has extended its activities both in increasing public awareness of what is being done under the National Parks Act and in improving the standard of public behaviour in the countryside. The major map publishers were asked to show the national park boundaries on their publications as opportunity occurred, and the first fruits of this approach have now matured. The Commission is deeply concerned at the growing demand from many quarters for the use of sites in national parks and other choice areas for projects which threaten to despoil the countryside. The example of Great Langdale has already been mentioned. Another is the proposed road-racing circuit in the Peak District National Park, a project now abandoned, for the time being, by the Derbyshire County Council. A third example is the proposal for an interception weir and works at Swindale Beck, where, in granting the Manchester Corporation an Order, the Minister, against the wishes of the National Parks Commission, also allowed the Corporation to retain unfettered power to construct a reservoir in this valley under the Act of 1919. The general implications of these development questions are discussed elsewhere in this issue (p. 335) in connexion with the Commission's proposals for amendment of the National Parks Act and use of the National Land Fund; but numerous examples are to be found among the details of cases handled by the Commission during the year, which are given in an appendix to this report.

THE TISSUE CULTURE ASSOCIATION

DECENNIAL CONFERENCE, 1956

IN the crisp air and flamboyant surroundings of the New England 'fall' the second Decennial Conference of the Tissue Culture Association was held at Woodstock, Vermont, during October 8–12. It was attended by more than two hundred scientists from many lands. The meetings were held in the village theatre, a converted mill on the banks of the River Ottauquechee, and the participants were mostly housed in the famous Woodstock Inn.

The purposes of the Conference were to review the progress made in both plant and animal tissue culture since the conference at Hershey in 1946, to consider the present trends of thought and research, and to outline problems for future investigation. Four main fields were covered, namely, nutrition and metabolism, morphogenesis, viruses and other pathological agents, and tumours in tissue culture; and each field was reviewed from these different aspects.

From the point of view of animal tissue culture, the topic which perhaps aroused the most general interest and speculation was the nature of the cells which constitute the so-called pure strains and clones, and their relation to their cells of origin in the organism. Many different strains of animal cells, each originally derived from a single cell, are now being maintained in various laboratories and at least two are being cultured on protein-free media. Morphologically, the cells in such strains are often greatly changed from their prototypes, and there is increasing evidence that they are also changed physiologically. It is becoming evident that cells in tissue culture tend to lose some of their specific characteristics, or at least to put them in abeyance, and to remodel themselves in relation to their new physical and chemical conditions. Whether the cells adapt themselves to the constituents of the medium in much the same way as bacterial colonies have been shown to adapt themselves to new substrates, and whether such strains can still be safely regarded as 'liver cells', 'skin cells' or 'heart muscle cells', etc., or should be regarded as a new type, 'tissue culture cells', promoted lively discussion both in public session and in private conclave.

It became increasingly clear during the conference that while these pure strains are invaluable for many types of research, for example, studies of the onset of malignancy, the growth of viruses and the reaction of cells to such agents, the results obtained by their use must be interpreted with reserve before they are applied to the physiology of the particular cell-type *in vivo*. Indeed, for more purely physiological studies, freshly explanted tissues are in some ways preferable. Furthermore, the report by Dr. W. R. Earle that of two strains of cells, originally derived from sister cells, one had become highly malignant while the other, though growing at the same rate, remained 'normal', provided the conference with much food for thought; so, too, did the discussions on the means by which viruses gain entry to particular cells. In the cancer field, the reasons for the invasiveness of malignant tissues and the factors influencing the transplantability of tumours received more attention than the actual process of their growth.

While it may be invidious to single out particular topics from a conference of such wide interest, the value of ciné-microphotography as an aid in endocrinological research was beautifully illustrated by Prof. P. J. Gaillard's film of the direct influence of the parathyroid on the behaviour of the bone cells, and especially of the osteoclasts, in bone resorption. The film clearly showed the solution of the bone matrix and the busy activity of the giant osteoclasts around the centres of solution.

In a somewhat similar field, related both to embryological development and to endocrinology, the papers by Dr. H. B. Fell and Dr. Rita Levi-Montalcini raised numerous problems concerning the interactions between cells of similar and different types. The observations of Dr. A. Moscona on the relative importance of organ-specificity and species-specificity in the reorganization of tissues from cultures of cells isolated by trypsinization, those of Prof. C. E. Wilde on the action of various homologues of phenylalanine on the differentiation of neural crest cells, and those of Dr. H. B. Fell and

the late Sir Edward Mellanby on the effects of excess of vitamin A on the conversion of a stratified epithelium to a mucous membrane, were all subjects arousing wide interest.

The botanical sessions revealed that, during the period under review, considerable attention had been devoted to refining and extending techniques and to critical re-examinations of the composition of standard culture media. Prof. H. E. Street's paper to the session on nutrition and metabolism emphasized both the importance of examining the availability of nutrients in existing media and the very limited state of our present knowledge regarding the growth requirements of isolated plant tissues and organs. Important progress in our understanding of the complex nutritive requirements of certain tissues seems likely to result in the near future from the extensive studies now being made of coconut milk and other complex supplements and from work on the physiological responses to kinetin and other pure growth hormones. Important progress in our understanding of morpho- and histo-genesis has followed from the increasing study of callus and organ cultures. This clearly emerged in the discussion which followed Dr. R. J. Gautheret's paper on "Histogenesis in Plant Cultures". The important part played by callus cultures in the study of virus diseases and of plant tumours was also emphasized in the papers of Drs. L. Black and A. C. Braun. Work in these fields is not only contributing to current views on the nature of viruses but also enhancing our understanding of the control of cell division. Extensive comparative studies of the nutritive requirements, physiology and chemical constitution of normal as against tumorous plant tissues have added greatly to our knowledge of cell physiology and, in the context of the Woodstock Conference, enabled the botanists to make an important contribution to the general discussions concerning the nature of cancer.

Those of us from outside the United States who were privileged to attend the conference owe our American colleagues a great debt of gratitude for their generous hospitality. Particularly are we indebted to Dr. P. R. White, of the Jackson Memorial Laboratory, Bar Harbor, for the very happy choice of Woodstock as a meeting place and for his excellent and detailed organization of the conference as a whole.

H. E. Street
E. N. Willmer

HYDROLOGY

DARCY SYMPOSIA

A MEETING of the International Association of Scientific Hydrology, which is a branch of the International Union of Geodesy and Geophysics, was held at Dijon during September 20–26. The place of meeting was chosen to honour the centenary of the publication of "Les fontaines publiques de Dijon" in 1856 by Henri Darcy, which has been considered to mark the birth of the scientific study of hydrology, and the Association therefore organized the 'Symposia Darcy'. The meeting was attended by one hundred and twenty delegates from a wide distribution of countries. It was agreed that papers should be restricted to (*a*) evaporation, (*b*) ground water, and (*c*) a study of floods.

The subject of evaporation was included principally for the purpose of preparing a programme for the next triennial assembly to be held in Toronto in September 1957. Accordingly, in the six short papers which were presented most of the authors treated the subject generally and gave summaries of experimental and theoretical studies in various parts of the world.

Evaporation and the allied subject of evapotranspiration are important factors in the estimation of rainfall/run-off relationships, particularly by those methods which are based on physical rather than on statistical data. As stated by R. K. Linsley and others, in a paper describing research in the United States, "these phenomena are major factors in the hydrologic cycle and of vital importance in many fields of applied hydrology". Another paper from America, by H. F. Blaney, who has done much original work on this subject, discussed the importance of evaporation to the irrigation engineer. W. Friedrich, of Germany, in describing work carried out in the Federal Republic, stated that on average no less than 450 millimetres out of a total precipitation of 771 millimetres is lost as a result of evaporation, thus "it ranks high on the 'water balance-sheet' ". From Switzerland came a description by P. Kasser of a 'water balance-sheet' study in the glaciated drainage basin of Mattmark in the Alps, in which the author suggested that, contrary to what is generally supposed, evaporation may increase with altitude in glaciated areas. G. F. Makkink, in a paper on "The Application of Research on Evaporation in Holland", expressed preference for methods for the calculation of evaporation which are based on radiation rather than on temperature.

C. F. Lapworth, from Great Britain, described experiments which have recently been carried out at a reservoir at Kempton Park, near London, to determine the amount of water loss due to evaporation. After correcting for rainfall and other factors, the derived evaporation over a period of twelve months beginning July 1955 is 660 millimetres, which compares well with a calculated value of 695 millimetres. A Working Committee was formed to prepare the programme for the Toronto Assembly. W. R. Rangeley (Great Britain) asked the Committee to consider the advantages of treating the subject on a broad basis, bearing in mind that evaporation as applied to hydrology is, as yet, an immature science; whereas V. Yevdjevic (Yugoslavia) expressed the view that attention should be confined to the role of evaporation in the hydrological cycle of a catchment.

The section concerned with underground water devoted most of the sessions to an appreciation of the so-called Darcy's Law and its application and validity over a wide range of ground-water problems under different flow conditions. J. Tixeront (Tunis) discussed the role of Darcy in the foundation of modern hydrology. The development of the fundamental flow equation under a series of specified conditions, as well as an extension to such problems as unsteady, unsaturated flow through porous media, was considered on a purely theoretical and mathematical basis by K. Hubbert (United States) and S. Irmay (Israel). In addition, G. de Josselin de Jong (Holland) analysed on a probability basis the path of an individual fluid particle as it passes through a porous medium.

Although many papers were concerned to some extent with the presentation of theoretical aspects of ground-water flow, more than half the authors discussed the practical application and interpretation of a wide variety of pumping-test techniques. This aspect proved to be one of the most important contributions to the symposium and members from no less than twenty countries had an opportunity of presenting their own experience in aquifers of different lithological types and to compare their results with those in other fields. The numerical determination of 'permeability' by several different approaches was discussed, including the examination of random samples of the aquifer by R. Schad (Germany), the application of pumping-test techniques by M. J. Goldschmidt and M. Jacobs (Israel), W. Kollis (Poland) and V. Pasvel (Germany), and more empirical and statistical methods by J. Ineson (Great Britain).

The validity of Darcy's Law evoked some discussion, and the apparent failure of methods concerned with the interpretation of both steady and non-steady state flow around a discharging well was shown by some authors, including G. Szilagyi and K. Ubell (Hungary), to be a function of such factors as the delayed yield by slow drainage from the aquifer and the distortion of flow lines near a discharging well, either where partial penetration of the aquifer occurs or where flow in an unconfined aquifer is under consideration. Interpretations of the form of the free surface around a discharging well were given by G. Nahrgang (Germany) and G. Schneebeli (France).

An important contribution to the broader field of underground water movement was made by E. Mosonyi and G. Kovacs (Hungary), E. Nemeth (Hungary) and D. K. Todd (United States), who discussed the use of laboratory models for the elucidation of flow conditions locally around either a source or sink and regionally in an aquifer. In some instances, the results of interpretation based on model studies compare favourably with observed conditions. The extended use of models can help materially in ground-water flow studies, which are now an integral part of many hydrological surveys.

R. Mugge (Germany), H. Schoeller (France), R. W. Stallman (United States) and G. Tison (Belgium) analysed the form of ground-water contours and fluctuations in ground-water levels, so that, under certain conditions, the formation constants of the aquifer, namely, hydraulic conductivity, transmissibility and coefficient of storage, could be determined. Problems relating to the recharge of an aquifer, particularly the determination of the aquifer characteristics, were dealt with by F. C. Mikels and F. H. Klaer (United States) and L. Schiff (United States). A comparison between predicted conditions, based on pumping-test determinations, and actual production figures confirms the theoretical approach. The increased use of ground water and the necessity to counter over-development of an aquifer, leading to both ground-water lowering and saline infiltration, by recharge projects, require more precise hydrogeological studies. Two contributions, by C. Schmid (Germany) and H. Tanaka and F. Yahagi (Japan), dealt with the application of Darcy's Law to oil production and to sub-surface flow near a dam, respectively. L. F. Ernst and J. J. Westerhoff (Holland) described some drainage problems in the Low Countries.

The discussion of the various papers confirmed the wide application of pumping-test techniques, based on the fundamental flow equation defined by Darcy, to the interpretation of ground-water problems. It was apparent that a large number of contributors regretted that methods concerned with the assessment of permeability of a water-bearing formation by the examination of the physical characteristics of random samples of that aquifer are still in use. Only by an interpretation of flow conditions in an aquifer *in situ* could a real estimate of its hydraulic characteristics and ground-water potential be determined.

The thirty-five papers presented on the study of floods covered a variety of important subjects and revealed in their bibliographical references the valuable part played by the International Association in bringing the hydrological work of any country to the notice of other nations.

Four papers, by Y. Simaika and H. El-Sherbini (Egypt), Ven Te Chow (United States), M. E. Walser (Switzerland) and T. Dalrymple (United States), respectively, described the flood problems in their countries and the hydrometric and hydrological methods used in their study. W. E. Hiatt (United States) reported how radar is now being used by the U.S. Weather Bureau for observations of rainfall, and K. N. Rao outlined the extensive hydrometeorological studies of rainfall which India feels bound to make in the absence of numerous long-period records of run-off, to enable water utilization works to be designed. H. Kreps (Austria) discussed the problem of measuring flood discharges and offered constructive proposals in that respect.

Aspects of river morphology were dealt with in papers from the United States and Japan, while S. Henin and X. Michon (France) provided a study in the estimation of erosion effects from gaugings of the solids transported by a river system.

The remaining papers were of a more analytical character. River hydraulics has been studied by W. Laszlöffy (Hungary), H. Strack (Germany) and H. Straub (Austria); the first examined the effect of icy conditions on the behaviour of a flood crest, the second the trend of the times of propagation of Rhine floods, and the third some aspects of stream-channel rugosity. V. Felber (Austria) discussed at length the influence of water below the ground surface upon flood run-off above, while R. Wind (Holland) at the other extreme reflected upon the interception of precipitation by vegetation.

Rainfall/run-off relationships were the subject of papers from Japan, Israel and Holland, and the employment of climatological observations in the evolution of flood discharge graphs was also discussed. The forecasting of flood flows was dealt with by J. Lambor (Poland) in two papers, by K. Szesztay (Hungary) and by T. Kinosita (Japan). The determination of the amount of the probable maximum flood flow of a river during a given period also received attention from several authors.

Nearly all the papers are written in French or English, with a few in German. The three sections are published separately and are now available through the secretary of the International Association of Scientific Hydrology, Prof. L. J. Tison, 61 rue des Ronces, Gentbrugge, Belgium, at a price of 550 Belgian francs for the complete set or 100 francs, 250 francs and 300 francs for the separate parts.

W. Allard
J. Ineson
W. B. R. King
W. R. Rangeley

PROTEIN METABOLISM IN MAMMALS

A MEETING of the Nutrition Panel of the Food Group of the Society of Chemical Industry was held at the Royal Society of Medicine, Wimpole Street, on December 12, with Prof. John Yudkin in the chair, Prof. A. Neuberger gave a lecture on "Some General Aspects of Protein Metabolism in Mammals".

Until about twenty years ago the endogenous body protein was considered to be inert, or only slowly metabolized, while the exogenous dietary protein was metabolized rapidly. In 1939, however, Schoenheimer showed that amino-acids labelled with nitrogen-15, when fed to animals, rapidly appeared in all the tissue proteins even in adult animals. As most mammalian tissue shows few cells in division, it was assumed that protein turnover is independent of mitosis and that the body proteins are in a state of dynamic equilibrium. Cohn and Monod, in 1953, presented evidence that appeared to be in conflict with Schoenheimer's findings. β-Galactosidase, a bacterial adaptive enzyme, was found to show no evidence of turnover.

The interpretation of isotope experiments, particularly with the complex tissue proteins, presents difficulties that were not fully appreciated by the earlier workers. These problems have been clarified by consideration of the simpler plasma proteins. Radioactive proteins appear in the plasma about one hour after injecting labelled amino-acids. Maximum activity is reached after six to eight hours, and the subsequent sharp fall in radioactivity is due chiefly to mixing with non-circulating plasma protein. Mixing accompanied by protein katabolism goes on for two to four days.

Blood and liver amino-acid levels equilibrate about eighty times as fast as blood and muscle levels, at least with glycine. This effect, due partly to slower blood flow in the muscles and partly to the existence of a blood-muscle permeability barrier, explains in part the greater time taken for radioactivity to appear in the muscle than in plasma or liver proteins.

Incorporation of labelled amino-acids into collagen is found when new tissue is being laid down, as in the growing rat, but very little incorporation into the collagen of the adult rat occurs.

The present view is that structural proteins have a low turnover, or none at all, while metabolic proteins have a high rate of turnover. Protein synthesis undoubtedly occurs in the mammalian cell in the absence of mitosis, as is shown by the observed turnover of proteins in the muscle cell, where mitosis does not occur. Such synthesis probably took place in the experiments of Cohn and Monod, but was masked by the large amount of protein formed in cell multiplication. Protein turnover is not a simple reversible biochemical reaction but probably represents the formation and decay of mitochondria or other subcellular elements.

All the available evidence points to the synthesis of proteins from amino-acids with the participation of nucleoproteins or ribonucleic acid. In certain circumstances 'exchange' reactions may occur, and peptides arising from the breakdown of one protein may be utilized in the synthesis of other proteins. Such reactions appear to be important in *in vitro* experiments, but from the present evidence it appears that they do not play a major part in protein synthesis occurring *in vivo*.

In the discussion, Mr. B. H. Doell said that an increase in the arginine content of plasma proteins had been reported on lysine-deficient diets. Prof. Neuberger commented that variation in the proportions of different proteins was a more likely explanation of such results than variation in amino-acid composition of the proteins. In answer to a question by Dr. S. Jacobs, Prof. Neuberger said that the various plasma proteins are not single substances but families of proteins, and replying to a question by Dr. A. E. Bender on the origin of endogenous urinary nitrogen, he said that endogenous and exogenous nitrogen are items on a nutritional balance sheet, but are biochemically indistinguishable.

B. H. DOELL

SALTS OF KARA-BOGHAZ-GOL

IN an article on the salt of Kara-Boghaz-Gol, G. G. Urasov and V. D. Polyakov (*Priroda*, No. 9, 61; 1956) mention a curious paradox, namely, that the fresh river waters are salting the Caspian Sea, whereas the salty waters of Kara-Boghaz-Gol are desalting it. This is because the Volga and other rivers are bringing annually enormous quantities of salts into the enclosed Caspian Sea, while Kara-Boghaz-Gol, a large gulf situated at its eastern margin, receives annually 130 million tons of salt from the Caspian Sea. Kara-Boghaz-Gol is separated from the sea by a narrow sand bar pierced by a channel through which the sea water flows constantly in one direction only—from the sea into the gulf. Surrounded by an arid desert, the shallow waters of the gulf are subject to constant evaporation and, until recently, enormous masses of mirabilite were precipitated during the winter months and piled up by waves and wind all along the shore of the gulf. The waters of the Caspian Sea have a very low salinity of 1·3, while those of the Kara-Boghaz-Gol have a salinity near that of the saturation point, which is 28·5. The precipitation of mirabilite ($Na_2SO_4.10H_2O$) is conditioned by the following equilibrium:

$$2\,NaCl + MgSO_4 + nH_2O \rightleftarrows Na_2SO_4.10H_2O + MgCl_2 + (n-10)H_2O$$

The study of salt formation in Kara-Boghaz-Gol began some sixty years ago under the leadership of N. S. Kurnakov and has since been continued by teams of the Kurnakov's Institute of General and Inorganic Chemistry. Boring records of salt deposits in the region of the gulf have shown several cycles of sedimentation, which can be correlated with the present trend of salt deposition. Thus from 1929 the level of the sea and consequently the amount of flow into the gulf began to fall, and this markedly affected the nature of the salt precipitates. First, the salinity of the water showed a steady increase since 1897 when it was 16·4, to 1941 when it was 28·0. Secondly, the water area of the gulf considerably decreased; and thirdly, besides mirabilite, sodium chloride and other salts were also precipitated.

As the highly developed exploitation of mirabilite represents an important industrial enterprise, in 1941

the Combinat 'Karaboghazsulphat' laid 12[7] km. of pipe lines from the sea into two enclosed basins of the gulf, to accelerate the natural evaporation and precipitation of salts. Detailed studies of these salts, however, showed a radical change in their composition, for besides mirabilite, they contained considerable amounts of astrakhanite or blödite ($Na_2SO_4.MgSO_4.7H_2O$), glauberite ($Na_2SO_4.CaSO_4$), epsomite ($MgSO_4.7H_2O$) and halite (NaCl). Besides, these salts contain carnallite, kainite, picromerite or schönite, bischofite, syngenite and kiserite. The brines also contain salts of boron, iodine, lithium, strontium, rubidium, cæsium and other rare elements. In 1947 the salt deposits of the gulf ceased to contain mirabilite, and the flow of water from the sea dropped from 12 km.[3] intake to 9 km.[3]. These changes greatly affect the salt industry in this region. Suggestions are made for either enlarging the water area of the gulf, or for utilizing the 'buried' deposits of mirabilite.

IS 'SUPER-REFINEMENT' LEGITIMATE IN X-RAY CRYSTAL ANALYSIS?

By Prof. A. I. KITAJGORODSKIJ

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WHEN an X-ray structure experiment is completed and the tables of the measured structure amplitudes $|F_o|$ have been drawn up, the next stage of the investigation is the determination of the signs of the structure factors.

In the search for signs we use—explicitly or implicitly—the idea of point atoms or of spherically symmetrical atoms. All structure-analysis practice shows that the signs found in this manner are, for the great majority of reflexions, independent of assumptions about the form of the atom. Only a very few weak reflexions have structure amplitudes the signs of which depend on the choice of f curves.

If we disregard such amplitudes, we can set up a three-dimensional series for the electron density, which ultimately becomes a certainty. The maxima of this series give the co-ordinates of the 'centres' of the atoms, with a precision limited by the cut-off and the imprecise knowledge of the F_o values. The influence of the discarded amplitudes with undetermined signs plays an altogether insignificant part. In my view, the structure analysis is then complete.

On the other hand, during the past few years some investigators have formed the view that it is possible to improve the results that are given directly by the three-dimensional electron-density series. For this purpose they suggest adjusting the f curves of all atoms in the cell, taking into consideration not only the features of electron distribution in the atom at rest, but also the anisotropy of the vibration of the atoms. In this manner a greater number of parameters may be introduced into the theoretical expression for the structure amplitude F_c, by the adjustment of which the so-called reliability index

$$R = \Sigma \, | \, |F_o| - |F_c| \, | \, / \Sigma \, |F_o|$$

can be minimized. (The method of minimizing R was originally proposed as a method of structure analysis that should be used for the refinement of results given by unresolved electron-density projections. This type of application of the minimization method will not arouse any objections.)

It is possible to set up a programme for a fast computer that would select the optimum parameters for minimizing. The machine can determine the atomic co-ordinates and the shape of the atom with *any* degree of precision, it can characterize the anisotropy of vibration, and find electron-density data. On the other hand, the investigator must have a clear conception of how long this procedure has a physical meaning.

It is obvious that the usefulness of minimizing R depends on two factors: (i) on the precision with which we know the experimentally determined quantities F_o; and (ii) on the ratio of the number of arbitrary parameters adjusted in minimizing R to the number of reflexions used.

It is obvious enough that the number of arbitrary parameters must be smaller than the number of reflexions. If all reflexions in the volume of the limiting sphere of the reciprocal lattice are used for establishing R, this requirement will generally be satisfied. On the other hand, when working with projections, the number of arbitrary parameters may be of the same order of magnitude as the number of reflexions. In such a case the procedure of minimization by using a very large number of parameters becomes meaningless.

An extensive programme for rendering results of X-ray structure analysis more precise is fundamentally restricted by the impossibility of determining F_o precisely.

If the values of F_o are known with a precision δ, the minimization of R to a value smaller than about δ is devoid of physical significance.

How precisely can the experimenter know the value of F_o? The values of F_o are calculated from the observed intensities I. In general, the measurement is done visually, and its precision is small. However, errors in intensity measurements can be avoided. The transition from I to F_o is therefore of interest. Errors that are unavoidable in practice are connected with absorption and extinction.

The absorption factor has to be determined for every reflexion by the formula

$$A = \int \exp \{ - \mu(s_1 + s_2) \} \, d\tau$$

It is practically impossible to carry out this integration for a crystal of arbitrary shape, and it is scarcely ever done in any structure work of this kind. By special measures (calculation or imparting a special form to the crystal) it is possible to estimate the absorption factor. But the precision of this estimate is greatly diminished with increase of absorption factor, and even in the best cases does not exceed

5–10 per cent. On the other hand, neglect of the absorption factor leads to considerable errors, and, apart from that, it is not a monotonic function of the angle θ. These errors usually amount to a few dozen per cent. Even for purely organic crystals, which have only a small absorption factor, a change of 10 per cent in the length of the path of a ray in a crystal of 1 mm. thickness causes a change in the absorption factor of the order of 5–10 per cent. (For copper radiation, $\exp(-\mu s) = 0{\cdot}94$, where $\mu = 6$ cm.$^{-1}$ and $s = 0{\cdot}01$ cm.)

An even more complicated problem appears to be the calculation of extinction. The formula used in structure analysis for the transformation of I into F_0 assumes the intensity to be proportional to the square of the structure amplitude. This is, however, only true for a small crystal block, in which we may disregard the internal dynamic interaction of the atoms. It is known that this is not true of a crystal used for structure analysis; but it is held that the dynamic character of scattering appears only for strong reflexions, and it is assumed that extinction depends only on the strength of reflexion, and not on the indices of the reflecting plane. This is obviously not so, even if only because the nature of the mosaic arrangement within the crystal is anisotropic, like all the other properties of the crystal. It is impossible to allow for accidental deviations (which depend on the mosaic structure of the crystal) from the proportionality of I to F_0^2 for medium–strong structure amplitudes. On the basis of the small number of calculated examples, we may assume that these deviations can in any event amount to 5–10 per cent.

From what has been said, it follows that great caution must be used in approaching other kinds of refinement of the results of X-ray structure analysis.

In my view, structure analysis has to be considered as complete when an electron-density series has been found that has been determined by means of signs that are independent of the appearance of the f curves. With this series we can find the 'centres' of the atoms. Attempts at finding additional physical details lack, in my view, any physical significance.

It seems to me that attempts at adapting X-ray structure analysis for the purpose of determining electron density or of determining the anisotropy of thermal vibrations are without foundation (I am not thinking, in this context, of the study of diffuse scattering). Other physical methods must be developed for solving problems of this nature.

The immense significance of X-ray analysis is that it appears to be the only method by which atom 'centres' can be allocated in space. The solution of the structure of penicillin is an example of the importance of results that may be attained in this way.

SERIAL RECORDING OF EXPERIMENTS

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IN many biological experiments results cannot be properly described in words or tables. Here photography can often be used as an accurate and practical method for recording, for analysis and for reporting results, given standardized conditions of scale, lighting, exposure, processing and sensitive material. Conventional photography, in terms of negatives and positive prints on paper, is time consuming and subject to a number of variable factors. Recent developments have made it possible to eliminate darkroom work entirely[1]. It is now possible to obtain a 'Reversal' film (35-mm. Gevaert Dia-Direct Reversal Film. Gevaert, Ltd., London, N.W.10), which is exposed in the camera, sent to a processing laboratory and returned carrying black-and-white positive, transparent images of the original subjects. Other manufacturers offer colour films which are used in exactly the same manner (35-mm. Kodachrome Type *A*. Kodak, Ltd., London, W.C.1; and 35-mm. Ilford Colour *A*. Ilford, Ltd., Ilford, Essex). It is thus possible to concentrate on the recording of phenomena and to leave the processing to large and specially equipped laboratories.

In our work on the culture of tubercle bacilli in semi-solid agar media[2,3], it was found that there was a need for accurate serial records of the growth of the organisms at intervals from a few days to a few weeks. The method of photography here described was developed to meet this need, and some of the earlier photographic results have been published[3]. The photographs which have been or will be published represent only a small fraction of the number that have actually been taken as part of the normal process of recording experimental results.

The purpose of the present article, since extensive illustration by photographs is impossible, is to emphasize the general value of this method for many kinds of biological research and some of the special uses to which we have put it in bacteriology.

Apparatus

The complete apparatus consists essentially of the camera, a suitable lighting system and a rectangular glass vessel containing xylol or alcohol (Fig. 1). The culture tubes are held in 'Terry' clips mounted on a horizontal arm from which they can be suspended

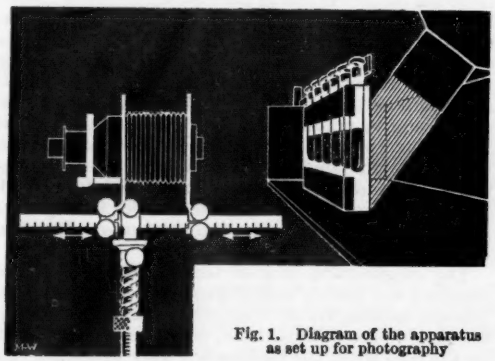

Fig. 1. Diagram of the apparatus as set up for photography

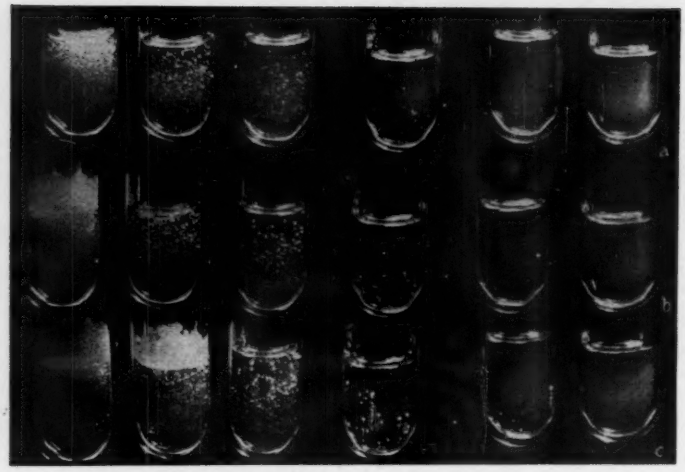

Fig. 2. Viable count of *Mycobacterium tuberculosis H* 37 *Rv* strain in semi-solid Kirchner medium. (*a*) After 13 days incubation; (*b*) after 17 days incubation; and (*c*) after 28 days incubation

vertically in the glass vessel either singly or in sets of up to six at a time. This arrangement greatly reduces specular reflexions—'highlights'—from the sides of the tubes and from the meniscus on each culture medium. A 500-watt spot light is placed behind and above the tubes, so that an almost parallel beam strikes them at an angle of approximately 45°. Particles in the path of the light produce scatter, and when a black matt background is used bacterial growth appearing either as a diffuse turbidity or in the form of separate colonies can be easily seen and photographed.

The camera support is an upright column with a helical screw in its centre, so that the camera can be raised or lowered without being thrown out of alignment in relation to the row of tubes. The instrument, a simplified model of the K.I. Monobar (Kennedy Instruments, Ltd., London, S.W.12), consists of a single bar, graduated in centimetres and millimetres. On this are mounted the front and back of the camera, which carry the lens and the film, respectively. They are connected by bellows, readily detachable for cleaning purposes. The front will accept any lens, as long as it is mounted in a standard panel. The rear fixture carries a focusing screen and magnifier set in a 360° rotating mount, so that the image can be composed in any desired direction. Once the picture is sharp, the viewing screen is moved back and the film magazine is inserted. This accommodates standard 35-mm. cassettes for thirty-six exposures. It is, of course, possible to have more than one cassette, so that different types of black-and-white and colour films can be used at will without having to unload first. Each magazine is fitted with an exposure counter, which works in conjunction with the film wind mechanism, and indicates the number of unexposed pictures which are left. A dark slide in front of the film is raised before an exposure is made and lowered before the magazine is removed from the camera.

The construction is such that all the fittings are standard and readily interchangeable. With a 90-mm. lens the camera will produce pictures at infinity when the bellows are collapsed and a magnification of × 2 on the film when the bellows are fully extended. As the bar on which both front and rear extension slide is graduated, the bellows can be set in definite positions, so that objects can be recorded repeatedly at a fixed image magnification or reduction. Magnifications of up to × 8 on the film can be obtained by replacing the 90-mm. lens with another of 25-mm. focal length.

Storage and Examination of Photographs

When the exposed film is returned by the processing laboratory as a strip of positive transparent pictures, each one is placed in a transparency mount. Of a large variety of different designs, the plain white cardboard mounts are perhaps the most practical. They are relatively inexpensive, and easy to manipulate. The film is sandwiched between two pieces of glass, which are then inserted into the centre of a cardboard square. A hinged flap is folded over and pressed against the cardboard. Both surfaces are coated with latex rubber or shellac, so that a firm seal results. The glass protects the image from dust, fingermarks and scratches, and the elasticity of the cardboard makes the mount virtually unbreakable. The weight of one transparency is 10 gm., while one conventional 3¼ in. × 3¼ in. lantern slide weighs 45 gm. As both sides of the slide consist of plain white paper, reference numbers and any other information are readily inscribed directly on the mount. A considerable number of transparencies can be stored in a relatively small space. We have used a filing cabinet which holds about 1,600 slides (Ace Associated Woodwork Co., Ltd., London, S.E.5).

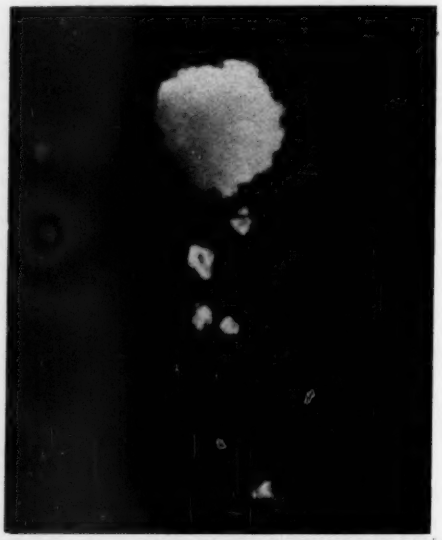

Fig. 3. Single colony of *Mycobacterium tuberculosis H* 37 *Rv* strain in semi-solid Kirchner medium with secondary colonies recorded at ×2½ and reproduced to give a final magnification of 20 × the actual colonies

Individual pictures can be viewed either by projection on to a screen in a darkened room or by rear projection at a magnification of × 4 on a desk viewer in subdued daylight (Kodak, Ltd., and Rank Precision Industries, Ltd., London, W.C.1). Long series of slides can be inspected with a hand lens against a transilluminated background on a segmented translucent panel.

Duplication and Publication of Transparencies

An elegant method for the preparation of duplicate transparencies from colour originals has been described[4]. Further copies from a black-and-white slide can, however, be made quite simply by placing it against an evenly transilluminated background and making further exposures through the camera at a 1 to 1 scale. Prints for publication can be obtained by making a negative and from it the print[5]. Figs. 2 and 3 are reproductions from such prints.

Applications in Bacteriology

The method has been successfully used in the following ways:

(1) *As a convenient means of recording permanently appearances which it is impossible to describe accurately in any other way.* For example, the growth of tubercle bacilli in semi-solid agar is very different at different times of incubation, and with inocula of different sizes. These points are illustrated in Fig. 2, which also shows the late development of a surface pellicle with large inocula and of secondary colonies with small inocula.

The shape and arrangement of both primary and secondary colonies can be recorded in greater detail by using the 25-mm. lens, which can give up to a × 8 magnification (Fig. 3).

(2) *Especially for serial recording of experimental results.* The size and shape of single colonies as they develop in different media can be carefully recorded. The development of secondary colonies can be followed, and by careful comparison of a series of photographs from the same tube it has been established that secondary colonies are 'shed' from the primary colony, presumably by detachment of single organisms or small clumps of organisms which sink vertically in the medium (Figs. 2 and 3). In drug sensitivity tests, the method of serial photography condenses in a compact form information both about the minimum inhibitory concentration of antituberculous drugs and about the distribution of drug-resistant individuals in the bacterial population[6].

(3) *For quantitative comparisons.* The rate of development of colonies of tubercle bacilli can be recorded by serial photography of the same tube or set of tubes (Fig. 1). Provided all visible colonies appear on the photograph the actual counting is in some ways more conveniently done not from the culture tubes themselves, but from the photographs. These have the advantage of recording in only two dimensions and are also available permanently for reference. Separate serial records can also be combined into a single, composite record by the use of a projector placed under a bench and facing upwards. Each image is focused on a glass plate lying flush with the top of the bench. The projected detail can now be traced on translucent paper, and any new information can be added, possibly in different coloured inks, from subsequent records of the same series. Other uses for this method can, for example, be found in the study of the growth of colonies of drug-resistant organisms on addition of a drug to a developing culture, or of organisms which require a particular growth factor on addition of this to a minimal medium. In such cases serial photography makes it possible to compare the growth before and after the addition of the drug or the growth factor, and to see not only that new colonies are appearing but also which colonies are the new ones.

From these examples it can be seen that the apparatus is highly flexible in its uses. The whole outfit can be kept in position in the laboratory, for it occupies very little space. It is always available for use at a moment's notice. Permanent records can therefore be prepared at once of evanescent phenomena in many branches of biology. Any unusual or important phenomena observed in the course of routine work, teaching or research can be recorded at once and, if necessary, at intervals with very little expenditure of time, energy or money.

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A NEW LIVING DEEP-SEA MOLLUSC OF THE CAMBRO-DEVONIAN CLASS MONOPLACOPHORA

By Dr. HENNING LEMCHE

Universitetets Zoologiske Museum, Copenhagen

WHEN dredging off the Mexican west coast, the *Galathea* Expedition made a rich haul at station 716. The many interesting animals found there include some specimens of a hitherto unknown patelliform mollusc, the study of which has already revealed so many interesting new facts that a preliminary note seems justified.

Class Monoplacophora Odhner, 1940

This name was proposed originally by Odhner (in Wenz[1]) to cover a group of extinct palæozoic molluscs hitherto regarded as primitive Patellacea, but differing from these in having six pairs of muscle scars arranged symmetrically on the inside of the shell. To-day, the diagnosis may be modified as follows.

Almost bilaterally symmetrical molluscs with internal metamerism. A single piece of shell covers the pallium which extends all over the dorsum. Anus postero-median. Coelomic cavities well developed. The metamerically arranged, paired auricles deliver the blood to the two symmetrical, long

ventricles, each on either side of the intestine. Metamerically arranged nephridia arise from the coelomic sacs to open on the surface in the pallial furrow. Gonads symmetrically arranged, possibly metameric, opening through the nephridia. Nervous system primitively orthoneurous.

Order Tryblidiacea Wenz, 1938

Monoplacophora with a head region and five well-developed metameres. The muscles of the head region indicate this part of the animal consists of three more metameres. The shell is spoon-shaped, cap-shaped, or conical, sometimes rather curved, with the apex more or less anterior or overhanging the anterior margin. No distinct pallial cavity, but there is a broad space or furrow all the way round between the pallium and the head and body, the pallial border thus continuing along the whole anterior side of the animal in front of the head. The mouth is placed ventrally at a little distance from the pallial margin. Dorsal tentacles broad, flap-like, placed on the ventral side of the pallial fold. Foot large and broad, almost circular, leaving a wide space between its anterior margin and the mouth disk. This triangular space is limited by a pair of crests carrying a number of appendages. Five (rarely less) pairs of double dorsoventral muscles, together with metamerically arranged smaller muscles to the ctenidia, etc. No distinct cerebral ganglia. Radula placed directly along the œsophagus. A crystal style is present in the stomach. Two symmetrical liver lobes are present. The intestine is long and strongly coiled. The number of body-metameres five, with as many pairs of ctenidia, nephridia and possibly auricles (and gonads ?), corresponding to the number of large dorsoventral muscles as mentioned above. (In some few of the fossil species, the number of body metameres may have been reduced.) The nephridia open to the exterior close to the base of the ctenidia which are, again, placed on the inside of the pallial fold. No accessory genital organs, the genital products being thrown out through the nephridia to the surrounding water. The larva develops into a stage with a spirally coiled shell before settling on the bottom. The mature larva is asymmetrical but not twisted, so that some shift in the symmetry seems to be induced during metamorphosis.

Family Tryblidiidae Pilsbry, 1899

Tryblidiacea with five pairs of dorsoventral double-shell muscles and additional smaller ones adhering to the shell immediately above the ctenidia. Shell cap-shaped or spoon-shaped, its apex sub-central or more or less overhanging the anterior margin. The ornamentation of the shell is composed of elevated radial lines crossing slightly raised concentric striæ. The larval shell apparently depressed, helicoid, and dextral. The triangular area behind the mouth is limited by obliquely placed crests which, in their hindmost part, are produced into dense tufts of slender, contractile, slightly branching appendages.

Genus *Neopilina* n.g.

Shell thin, almost circular in outline, apex curved, scarcely overhanging anteriorly. No visible muscle scars on the shell. The genus differs from the fossil *Tryblidium* Lindström, 1880, and *Vallatotheca* Foerste, 1914, which have solid shells with strong muscle scars, from *Cyrtonella* Hall, 1879, which is higher, somewhat compressed, and which seems to have less than five pairs of muscle scars. *Helicoconcha* Ulrich and Scofield, 1897, is said[3] to have a few isolated muscle scars arranged in a horseshoe which, posteriorly, form an acute angle. *Proplina* Kobayashi, 1933, is said[3] to have distinct muscle scars, and the shell is higher than usual. Finally, the genus *Pilina* Koken, 1923, comes very close to the present genus. Still, it differs in possessing visible muscle scars on the shell, and in that the anterior third of the shell margin is bent somewhat downwards. If the finest details in the picture given by Knight[4] are sufficiently reliable, the apex of *Pilina* is similar to that of *Neopilina* in being slightly—almost unrecognizably—asymmetrical. The difference in the muscle scars would seem to justify the establishment of a new genus, *Neopilina*, gender feminine, type by monotypy *Neopilina galatheae* n.sp.

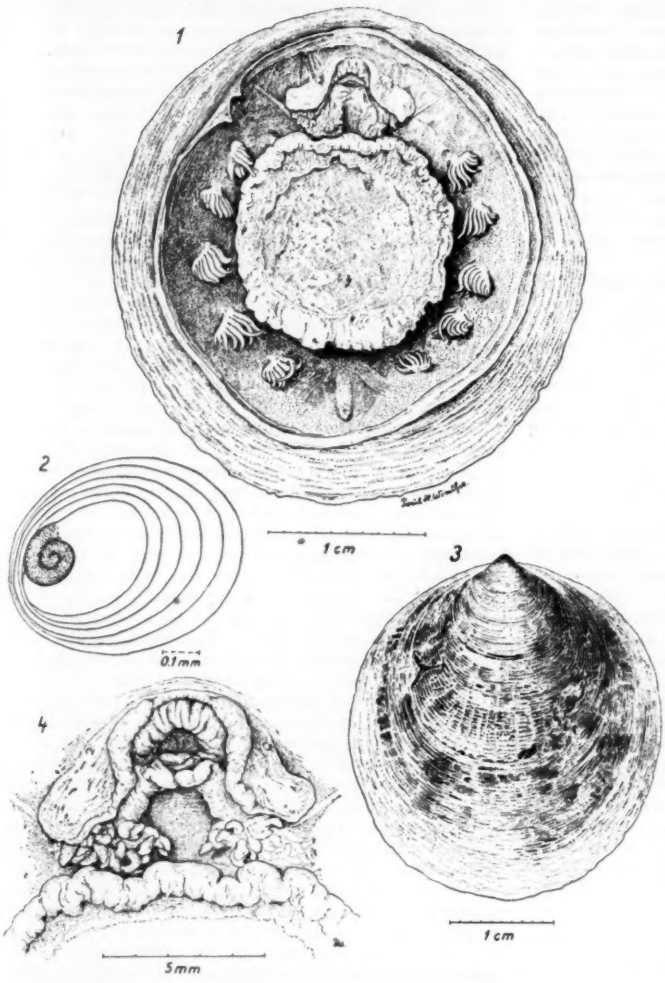
Neopilina galatheae n.sp.

Material: 10 specimens and 3 extra shells from the *Galathea* Expedition, Station 716. 9° 23′ N., 89° 32′ W., May 6, 1952, 3,590 m. depth, dark muddy clay, herring otter trawl. All the specimens are being kept in the Zoological Museum of the University of Copenhagen. One of the specimens has been cut into transverse sections of 50μ thickness.

The shell (Fig. 3) is spoon-shaped, almost circular in outline, the largest specimen measuring 37 mm. in length, 33 mm. in breadth, and 14 mm. in height. The apex is anterior, being curved so as to point obliquely downwards in the median plane, and placed about 8 mm. over the front margin. When undamaged, the margin of the shell shows no incisions or irregularities. The inner surface carries softly raised waves combined into a stretched meshwork. The whole shell is very thin and fragile, breaking when dried. The periostracum is blackish at the apex, gradually changing into a light brown on most of the shell. It covers the whole outside of the shell and continues on the inside of the outermost thin part of the mantle to the periostracal shell gland placed at some 2 mm. distance from the very margin. Below the periostracum, the shell consists of a well-defined layer of prismatic calcareous substance. The sections have shown that there are a very few and extremely thin lamellæ of what may be mother-of-pearl substance between the calcareous prisms and the epidermis cells, many of which, however, seem to be arranged so as to correspond closely to the arrangement of the prisms.

The surface of the shell shows closely set lines of growth crossed by 30–50 very tiny, narrow and slightly elevated ribs, radiating from the very small apex. About every fifth of the lines of growth is somewhat stronger and rises a little above the surface of the following part of the shell. The whole structure is distinct in the region near the apex but becomes coarser and fades away gradually farther down the shell.

There is a distinct dextral larval shell of about 0·15 mm. in diameter and forming one and a half whorls, of the type characteristic of pelagic larvæ (Fig. 2). The transition to the adult shell is rather abrupt, marked as it seems by a slightly impressed line across the whorl, beyond which the shell broadens suddenly to spread like a flat cap. This larval shell was present in one, only, of the thirteen specimens (Spec. 3), whereas the apices of the other shells



Neopilina galatheae: 1, ventral view of holotype (specimen 1); 2, apical part with larval shell of specimen 3; 3, dorsal view of the shell of the holotype; 4, ventral view of the anterior part of the body of specimen 4 showing the mouth in the contracted velar disk, surrounded by the rhinophores, between which and the front margin of the foot are seen the tufts of appendages

showed slight impressions only, indicating that a larval shell had been present.

The animal in its shell can be studied from the ventral side (Fig. 1). The main part of this side is occupied by a circular foot which is muscular only in a brim along its margin all the way round. In front of the foot there is a flat, triangular area which seems to have no distinct counterpart in any other known mollusc (Fig. 4). This area is limited on both sides by protruding keels which, in the median plane, are separated totally through a narrow slit. In their postero-lateral part, each of these keels is developed into a tuft of elongate tentacle-like and slightly branching appendages which are supposed to form a filtering organ and, at the same time, may be the seat of chemical sense organs. In front of the area just mentioned, the mouth is found somewhat behind the centre of a velum-like disk with sharp margins (strongly contracted in most specimens (Fig. 4)). On the sides of and a little anterior to the mouth disk, a pair of flattened, thick, flap-like appendages appear which continue into ridges, disappearing at some distance from the median plane.

There is no true pallial cavity. A deep and broad furrow surrounds the whole ventral side of the animal inside the extensive and, in its outer part, very thin mantle. A distinct, short papilla carrying the anus is situated posteriorly in the median plane on the inside of the mantle. There are five pairs of typical ctenidia placed two-thirds up the inside of the pallial fold. Each ctenidium consists of a broad and flattened stem tapering outwards, and 6–7 elongately triangular, flattened branches arising successively from the postero-medial side of the stem.

Quite a number of distinct muscles can be seen from below. Some are arranged in different streaks lateral to the anus, others run forward from the bases of the ctenidia. Still other fibres are seen encircling the foot in the uppermost part of the pallial furrow.

When the shell is removed, additional muscles are seen dorsally. Five pairs of strong, double muscles dominate, being inserted on the shell central to the gills, at the level of the bottom of the pallial furrow. These muscles are dorso-ventral and serve the retraction of the foot. Three similar sets of muscles form a composite figure on each side of the head.

Although a specimen has been sectioned, the detailed study has not by far been completed, and only a few of the more important characters will be mentioned here. A detailed description is to be published in the "*Galathea* Reports" as soon as possible.

The alimentary canal runs medially upwards along the anterior end of the animal, carrying in this part a very strong radula 15 mm. long and nearly 1·5 mm. broad. There are fifteen rows of teeth, each row being composed of a three-cuspidate median tooth and—on each side—three lateral, strong, hook-shaped teeth and a pectinate tooth not yet analysed in detail. The radula is placed directly in the œsophagus without any radular sac. The stomach is situated close to the apex of the shell, giving off two symmetrical liver branches which run backward in the body. The intestine is thin-walled but very voluminous; it forms six large coils occupying most of the space under the central part of the shell, ending up in the broad, median rectum. The details of the circulatory system have not yet been cleared up but, judging from the simpler conditions found in connexion with the two hindmost pairs of gills, there are as many auricles as there are gills, the blood passing from the body-cavities to the gills and from

there along the nephridia to the auricles, which, again, deliver the blood to the ventricles. These last are constituted by two long and thin-walled structures, each on either side (of the hindmost part ?) of the intestine. There are five pairs of nephridia opening at the bases of the respective ctenidia. The gonads are paired, and the eggs have been seen on their way out through the nephridia, but it is not yet known whether the gonads are metameric as are the ctenidia, etc. The sexes are separate. No accessory genital organs of any kind have been found, and it is almost certain that the eggs are delivered directly into the surrounding water.

The nervous system has not yet been sufficiently studied for a closer description. The innervation of the gills and nephridia and the neighbouring parts of the mantle seems to follow the same scheme as in gastropods, with a branchial ganglion for each gill. Probably, there are the same two pairs of longitudinal stems as in the Polyplacophora; but there is also what appears to be a nerve ring very far out in the most peripheral parts of the mantle, with connexions to each of the branchial ganglia. The pedal ganglia are well developed, whereas the cerebral ones are less distinct.

As to the mode of living, there are certain indications that the animals are filter feeders lying on their back. First, the weak foot is no useful tool for strong movements. Secondly, the very thin shell margin with the periostracum bend round to the inside and a nerve ring placed almost at the margin of the shell would seem to prohibit any movement of significance by creeping. Thirdly, the water intake for the gills must be from the anterior end, where no structures at all for admitting such an intake are found, if the animals are not placed on their back. Fourthly, a not yet determined phoronid(?) has been found to form small colonies on the lower third of the anterior side of the shell, on four of the present specimens, but never farther up towards the apex. So, it would seem logical to accept provisionally the idea that the animals use an upside down position. The intestine was crowded with radiolarian remains, some of them with the soft parts still present. It would seem probable, therefore, that one of the main food-sources of *Neopilina* is radiolarians.

As to the systematic position of the species, it is clear that it forms a very primitive link between the Polyplacophora and the Cephalopoda as typified in the nautiloids. The position of the radula is similar to what is found in the Solenogastres (or Aplacophora), whereas the similarities to the Gastropoda seem to be limited to the possession of a dextral larval shell. It will need further investigation to find out whether the tuft of appendages corresponds to the epipodial fold in primitive Gastropoda and in the Polyplacophora, to the tentacles or arms in the Cephalopoda, to the cirrhi of the Scaphopoda and/or to the labial palps in Lamellibranchs. Also, the close similarity of a typical segment of an annelid to that of the gill-bearing region in *Neopilina* invites further study.

It would seem, therefore, that *Neopilina* should belong to a very ancient stock. In fact, its early ancestors are already known. Wenz[1,2] has shown that the group of Cambro-Silurian Patellacea characterized by six pairs of muscle scars on their shells should be separated to form a special order, the Tryblidiacea, which N. Odhner (in Wenz[1]) was even inclined to regard as quite a separate group, the Monoplacophora.

Now, the dorso-ventral muscles in *Neopilina* are arranged in exactly the same way as in these Tryblidiacea, three sets of muscles combining to form the anterior 'scar' (the muscle scars in *Neopilina* are to be inferred from the position of the muscles themselves), and five pairs of separate, equidistant, double insertions farther back. The shell in the Silurian genus *Pilina* is indeed so much like that of the present genus that the differences may prove to be of only subgeneric value.

Two other fossils should be mentioned briefly here to show the proposed contents of the class Monoplacophora, namely, *Scenella* Billings, 1872, and *Stenothecoides* Resser, 1938, for both of which Rasetti[5] has described the muscle scars. In *Scenella*, there are three distinct double pairs of muscle scars slightly irregularly arranged on the middle of the sides of the shell immediately below the apex, whereas the whole anterior part of the shell is devoid of scars with the exception of one pair of very small protrusions. Posteriorly, three pairs of smaller, double scars are visible. The position of the three pairs of main scars seems to me to indicate that they correspond to the combined ones in the head of the Tryblidians—in which group the apex is anterior, that is, placed above the fused head 'segments'. The posterior three segments in *Scenella* would then constitute the rudiments of the later body-metameres, of which the Tryblidians have five pairs. In *Stenothecoides*, the apex has moved still more towards the front end of the shell. The scars in the head region are not known, but it is tempting to suppose that the many strong, apodeme-like scars along the sides of this shell divided that animal into quite a number of body-metameres. If so, *Stenothecoides* would become something in between molluscs, annelids and arthropods. For the moment, however, I would prefer to include among the Monoplacophora those primitive molluscs or mollusc-like animals which have a dorsal shell, a varying degree of metamerism, no torsion but always a certain slight asymmetry although in the main bilaterally symmetrical. The class would comprise the three orders Scenellacea, Tryblidiacea and Stenothecoidacea, as defined above by differences in their metamerism.

The striking similarity in the organization of the muscles in *Scenella* and in primitive gastropod larvæ just before torsion[6] is now being studied, but it is too early to draw further conclusions from the new find. Only, it should be mentioned that the attempt by J. B. Knight[3] to reconstruct the phylogeny of the Mollusca can now be evaluated in a way never before expected. Some of his assumptions have proved to be erroneous but, thanks to his very clear and ingenious exposition of the history of that whole group, it would now seem possible to reach an acceptable explanation of the phylogeny of the whole phylum Mollusca.

I wish to express my gratitude to the editorial committee of the *Galathea* Expedition for permission to treat this valuable material, and to many colleagues for discussions. Special thanks are due to Dr. Gunnar Thorson for demonstrating the presence of the larval shell, and to Prof. K.-G. Wingstrand for the excellent preparation of sections.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Relation between the Effects of Gibberellic Acid and Indolylacetic Acid on Plant Cell Extension

IF gibberellic acid, a metabolic product of the fungus *Gibberella fujikuroi*, is applied to growing plants, it commonly causes a marked increase in stem internode length, mainly attributable to cell extension. Some dwarf varieties of pea are particularly sensitive, visible increases in internode-length resulting from doses of 0·01 μgm. gibberellic acid per plant[1]. Auxins applied in a similar way have little or no effect; but, since auxins do induce cell extension in some circumstances, comparisons of the physiological effects of auxins and gibberellic acid have been made. It has been shown[2] that gibberellic acid is inactive or of low activity in many conventional auxin assays, does not stimulate rooting of cuttings, does not inhibit development of lateral buds in decapitated plants, does not prevent leaf abscission and neither stimulates nor seriously inhibits root growth; similar observations have been made[3] with the related material gibberellin *A*. Thus the spectrum of activity of gibberellic acid and gibberellin *A* is very different from that of the auxins; Kato[3] has concluded that the mode of action is different from that of the auxins, but we[2] have preferred to leave the question undecided in the absence of more positive evidence. We have recently made some observations which throw light on the relation of auxin activity to that of gibberellic acid.

We have used a technique adapted from Galston and Baker[4]; 5-mm. sections, cut from unextended internodes of dwarf peas (var. Meteor) grown in light, are floated on phosphate buffer (*p*H 6·1), incubated at 15° C. in a light intensity of 800 ft.-candles, and the longitudinal extension of the sections measured after 24 hr. In a series of nineteen experiments with various concentrations of gibberellic acid in the buffer, only small increases in extension were produced, rarely reaching statistical significance; similar results were obtained when 2 per cent sucrose was added to the medium. Indolylacetic acid does induce extension of the sections, the optimal concentration being 10 μgm./ml. In the presence of such concentrations of indolylacetic acid, an extra effect is produced by gibberellic acid; the results of three experiments are summarized in Table 1. Factorial analysis of the data in each case showed a highly significant interaction between gibberellic acid and indolylacetic acid. Thus the former depends on the presence of the latter for its effect on cell elongation in the system studied, which would appear to approximate to conditions in the normal intact pea plant fairly closely. Furthermore, in so far as in the presence of optimal concentrations of indolylacetic acid still further growth is induced by gibberellic acid, it seems reasonable to conclude that its mode of action is different from that of indolylacetic acid, though in some way they are interdependent.

Table 1. MEAN LENGTH (MM.) OF PEA INTERNODE SECTIONS AFTER 24 HR. GROWTH IN BUFFER WITH ADDITIONS OF SUCROSE, INDOLYLACETIC ACID (10 μGM./ML.) AND GIBBERELLIC ACID (10 μGM./ML.); RESULTS OF THREE EXPERIMENTS, ALL RESULTS BEING MEANS OF THIRTY REPLICATES

Sucrose (per cent)	Other additions	I	II	III
None	None	6·8	6·8	6·6
	Indolylacetic acid	8·2	8·6	8·0
	Gibberellic acid	6·5	7·0	6·5
	Indolylacetic acid + gibberellic acid	9·0	9·1	8·3
2	None	6·9	7·6	6·6
	Indolylacetic acid	9·0	9·1	8·1
	Gibberellic acid	6·9	7·2	6·5
	Indolylacetic acid + gibberellic acid	9·6	9·9	10·0
Standard error		0·17	0·15	0·15

The concentration of gibberellic acid (10 μgm./ml.) used in the experiments just described is relatively high. In the presence of 10 μgm./ml. indolylacetic acid, a significant extension response is produced by 0·01 μgm./ml. gibberellic acid and a nearly maximum response by 0·1 μgm./ml. Even at 100 μgm./ml. gibberellic acid shows no toxic effects. Gibberellic acid significantly increases extension in the presence of indolylacetic acid in concentrations as low as 0·1 μgm./ml., but the greatest response is obtained in combination with 10 μgm./ml.

Though gibberellic acid alone does not significantly increase extension in light of internode sections from pea plants grown in light, it does induce elongation in darkness of sections from etiolated plants[2,5]. This interesting difference is as yet unexplained.

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Distribution of Adrenaline and Noradrenaline in the Hen Adrenal Gland

RECENT studies have indicated that the mammalian adrenal medulla contains both adrenaline and noradrenaline, which can be demonstrated both chemically and histochemically. In the adrenals of several mammalian species, specific chromaffin cell groups have been shown to be carriers of most of the adrenomedullary noradrenaline, while the other cells contain predominantly adrenaline[1]. Studies on vertebrates other than mammals are rather few, but a similar secretory dualism has been demonstrated in the adrenal medulla of the lizard[2]. In this animal the cord of chromaffin cells embracing the cortical tissue peripherally is apparently specialized in the secretion of noradrenaline, whereas islets of chromaffin tissue intermingling with the cortical cells themselves apparently contain predominantly adrenaline. To my knowledge no report of the distributions of noradrenaline and adrenaline in the adrenals of birds has been published.

In the course of an investigation of the adrenals of various domestic animals, I observed that the

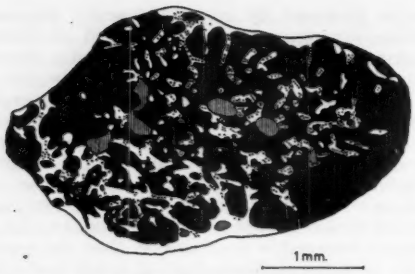

Fig. 1. Camera-lucida drawing of the adrenal gland of a hen. The cortical tissue is shown black, the chromaffin tissue white. Each black dot indicates one noradrenaline cell. Blood vessels are marked with vertical lines

chromaffin tissue of the hen adrenal gland has some particularly interesting features, which differ from those of all other medullary tissues hitherto examined. Adrenals of adult, egg-laying hens were used. Slices of fresh adrenals were examined for (1) the chromaffin reaction, which is positive for both noradrenaline and adrenaline, (2) the formalin-induced fluorescence[3], and (3) the iodate reaction[4]. Methods (2) and (3) selectively demonstrate the cells containing noradrenaline. Fluorometric determinations of adrenaline and noradrenaline, made after chromatographic separation of these catechol amines, showed that about one-third of the total catechol amines of the hen adrenal is noradrenaline.

The well-known fact was confirmed that the chromaffin tissue is intermingled with the cortical cells in the adrenals of birds (Fig. 1). The intensity of the chromaffin reaction was closely the same in all chromaffin cells. The cells containing noradrenaline were demonstrated either by the fluorescence method or by the iodate method with identical results. The distribution of these cells is indicated by dots in Fig. 1. The size of each dot corresponds approximately to the size of each cell. Most of the cells containing noradrenaline were solitary in the chromaffin tissue of the hen adrenal and surrounded by cortical cells or chromaffin cells which were essentially iodate-negative and which did not show appreciable fluorescence after fixation in formol–calcium. Such histochemical properties apply to cells which contain and secrete predominantly adrenaline. The noradrenaline cells were seemingly distributed at random in the tongues and islets of the chromaffin tissue. Certainly there was no tendency of the noradrenaline cells to predominate in the peripheral layers of chromaffin tissue, in contrast to conditions in the adrenals of the lizard.

It is of interest to note that although the cells containing noradrenaline tend to gather into groups or cell islets in the mammalian adrenal medulla, solitary, randomly distributed noradrenaline cells have been seen in autografts of the rat adrenal medulla[5]. Both in the hen adrenal and in the adrenal autografts of the rat, there seems to be no correlation between the sites of cells secreting the methylated variety of catechol amines and the site or amount of cortical tissue. This fact, together with the observation that the ratio of noradrenaline to adrenaline remains constant during the postnatal development of the rat adrenal gland, in spite of a considerable increase in the relative size of the cortex (unpublished work), suggests that the two kinds of adrenomedullary cells are independent of each other, and that the quality of the catechol amine they secrete is no decisively dependent on the concentration of cortical hormones in the blood surrounding them, as has been supposed[2].

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Biological Potency of Zeta-Tocopherol

ζ-Tocopherol was first isolated from cereal grains by Green, Marcinkiewicz and Watt[1], and was shown to be identical (apart from the presumed difference between the natural optically active and the synthetic racemic forms) with 5 : 7-dimethyltocol, synthesized many years previously by Karrer and Fritsche[2] and by Bergel, Copping, Jacob, Todd and Work[3]. The latter two groups of workers, in a series of papers, disputed the biological potency of 5 : 7-dimethyltocol. Karrer and his co-workers[4,5] stated that the substance had similar activity to β-tocopherol (that is, 30–50 per cent of the potency of α-tocopherol) whereas the British workers[6] maintained that 5 : 7-dimethyltocol had the same potency as α-tocopherol. Both groups used the rat anti-sterility assay as a measure of biological activity. Since ζ-tocopherol is an appreciable constituent of the tocopherol complex in cereals (for example, 44 per cent of the total tocopherols in barley), it is important that its potency, relative to α-tocopherol, be known.

We have synthesized DL-ζ-tocopherol by the original Karrer method from 2 : 6-dimethylhydroquinone and phytol. The crude product was not crystallized through the allophanate or *p*-nitrophenylurethane (since it was suggested by the British workers[6] that the choice of derivative might affect the potency of the product) but was purified directly by chromatography on alumina (Peter Spence, Type '0'). Elution with benzene–ethanol gave a dark oil, which, on extraction with methanol, gave ζ-tocopherol of 97 per cent purity. The purified tocol was acetylated and the acetate distilled to give DL-ζ-tocopheryl acetate (97 per cent pure, checked by two-dimensional paper chromatography[1]).

The biological potency of this DL-acetate in the rat anti-sterility test was determined, relative to DL-α-tocopheryl acetate. Duplicate assays gave the relative potency as (1) 0·48 (*P* 95 limits, 0·27–0·96), and (2) 0·57 (*P* 95 limits, 0·31–1·2). These results combine to give a relative potency of 0·52 (*P* 95 limits, 0·33–0·81). DL-ζ-Tocopheryl acetate was also tested for its activity in reducing the degree of hæmolysis of erythrocytes in the dialuric acid test of Gyorgy and Rose[7]. 0·93 mgm. and 0·47 mgm. doses given orally to male or female rats deficient in vitamin E produced approximately 80 and 50 per cent reduction, respectively, in the degree of hæmolysis, 24 hr. after dosage. In the same test, a 60 per cent reduction was effected by either 0·13 mgm. or 0·27 mgm. of

DL-α-tocopheryl acetate. No success met our efforts to use the dialuric acid test as a quantitative assay, but it appears, as has been previously found with other non-alpha tocopherols[8,9], that ζ-tocopherol is much less active than α-tocopherol in the dialuric acid test.

Some comments on the composition of the vitamin E-free diet for the rat assay are worth recording. The use of a standard diet consisting mainly of vitamin-free casein, starch, sugar and yeast, and containing 1 per cent of olive oil, B.P., did not produce satisfactory deficiency in rats. It was shown, by paper chromatographic assay, that the diet contained 1 μgm./gm. of total tocopherols (nearly all alpha) and that the olive oil contained 72 μgm./gm. of tocopherol (100 per cent alpha). It may be noted that Mason and Harris[10], recommending a standard diet for vitamin E assay, considered 10 per cent olive oil a suitable alternative to 10 per cent lard. It may be assumed, therefore, that either olive oil of commerce varies considerably in its tocopherol content, or that large amounts of olive oil in a diet free from vitamin E can only be tolerated if the vitamin A supplement is given as cod liver oil. In our diets, vitamin A was given as a high-potency concentrate, adding practically no fat to the ration. When 1 per cent lard replaced 1 per cent olive oil in our diets, consistent vitamin E deficiency was obtained. The lard used was found to contain less than 0·03 μgm./gm. of total tocopherols.

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A Second Major Constituent of the Blood oxidized at the Brain

Glutathione was suspected to be involved in respiratory or redox processes even before its structure was known. Among the very extensive subsequent work[1] there appears, however, to have been little attempt to appraise such a role in animals by direct determination of the levels of the oxidized and reduced forms of glutathione in arterial and venous blood, which is rich in glutathione.

A newly developed glyoxalase method[2] has now been applied to determining the two forms of glutathione in arterial and cerebral venous blood from the conscious rabbit (Table 1). The venous blood was obtained at the junction of the superior longitudinal and lateral sinuses (Rodnight, R., unpublished work), and the arterial blood from the central artery of the ear. Reduced glutathione is seen to be oxidized at the brain. The change in glutathione is by weight two-thirds of that in glucose, and involves the oxidation of 30 per cent of the reduced glutathione supplied to the brain: a much greater proportional change, therefore, than in glucose.

Table 1. Constituents of Arterial (*A*) and Cerebral Venous (*V*) Blood of the Rabbit

Samples were taken simultaneously; values in mgm./100 ml. Hæmatocrits, also determined, showed no arterio-venous difference

Animal; specimen	Reduced glutathione	Oxidized glutathione	Glucose
I; 1	*A*, 26·4; *V*, 20·0	*A*, 10·7; *V*, 16·9	*A*, 121; *V*, 108
I; 2	*A*, 20·9; *V*, 12·3	*A*, 16·0; *V*, 24·6	*A*, 98; *V*, 89
II; 1	*A*, 25·8; *V*, 19·9	*A*, 11·1; *V*, 16·9	*A*, 95; *V*, 85
Mean and S.D., 8 specimens	*A*−*V*, 7·2±2·6	*V*−*A*, 7·5±2·4	*A*−*V*, 11±3·6

It is very interesting and surprising to find such large changes in glutathione at the brain, for calculation from data regarding its respiratory and carbohydrate exchange *in vivo* has shown this to give an almost exact balance in terms of oxygen, glucose, lactate, pyruvate and carbon dioxide[3]. However, present results do not seriously disturb this balance, as the change of —SH to —SS-glutathione uses only 1/41 of the oxygen needed for complete oxidation of the same weight of glucose. Nevertheless, this qualitatively very different type of oxidation at the brain may contribute to the failure to maintain the organ by perfusion with simple solutions, the necessity for including erythrocytes in perfusion systems, and the advantage accruing in such experiments from passing the erythrocyte suspensions through the liver[4]. For presumably the glutathione oxidized at the brain is reduced elsewhere in the body (McIlwain, H., Martin, H., Rodnight, R., and Tresize, M. A., unpublished work); as the substance does not appear to leave the red cell rapidly[5], carrier systems or diffusible oxidizing agents in the plasma must be implicated.

The changes in glutathione recorded in Table 1 have been confirmed by iodometric titration, by recovery of glutathione added to blood, and by different precipitations and pretreatments of the blood samples analysed.

We are grateful to the Medical Research Council for a grant in support of these studies.

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Crystallization Patterns of Sodium Chloride in Bovine (Uterine) Cervical Mucus as related to its Consistency

The presence of fern-like patterns of sodium chloride ('palm leaves') in dried cervical mucus taken from women during the ovulatory phase of the sexual cycle becomes less marked during the post- and premenstruum and gives place to a cellular structure in pregnancy. This phenomenon has been used for various diagnostic purposes by a number of gynæcologists ('P.L.' test: see Zondek[1]). Parallel observations on the bovine are reported by Pozo Lora[2] and Coluzzi and Battistacci[3]. At the suggestion of Prof. B. Zondek, we have made a study of this method as a possible test for bovine pregnancy and other hormone-dependent conditions, the results of which are being published elsewhere. We have also described a bovine pregnancy test in which the consistency of the mucus is determined by measuring the time of extrusion (t sec.) of a column of length 1 cm. from a small capillary tube (diameter $\sim 0{\cdot}7$ mm.) under constant pressure (P gm./mm.^{2}). An index of consistency, $Pt^{1/2}$, is found to be independent of pressure and, on exceeding a certain magnitude, is indicative of pregnancy[4]. Further validation of this test, which is most efficient at about 28 days after conception, will also shortly be published.

For the purposes of the 'P.L.' test more than 200 dried mucus samples were subjectively scored, without knowledge of the consistency, from 1 to 8, 1 representing very marked fern-like structure, and 8 highly cellular structure. Though it is not easy to establish a criterion for pregnancy on the basis of these scores ('P.L.' numbers), we have calculated the average value of $Pt^{1/2}$ corresponding to each of them and have found a highly significant relation. In view of the discontinuity and lack of equality of interval in the 'P.L.' scale, a correlation coefficient would not be a good statistic and the results are best shown in graphical form (Fig. 1).

The data comprise tests on non-pregnant cows and also in pregnancy, from 17 to about 30 days after conception. In pregnancy, quite a few samples have too high a consistency to be measured and these are assigned a ceiling value ($Pt^{1/2} = 35$), which means that the highest values of $Pt^{1/2}$ should be increased somewhat. This would make the curve remarkably linear, using a logarithmic plot for $Pt^{1/2}$.

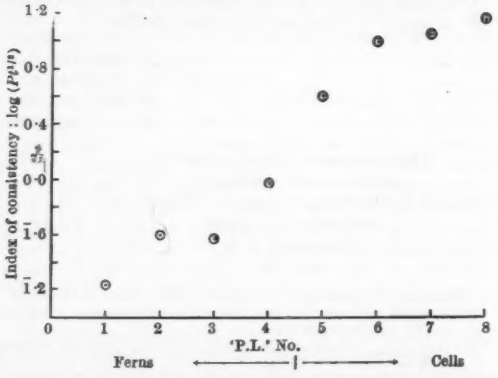

Fig. 1. Relation between 'P.L.' numbers and index of consistency for 104 Shorthorn and 104 Friesian cows, non-pregnant and in early pregnancy

We have carried out experiments in which the mucus has been diluted two-, three- and six-fold with distilled water before drying, and although there is some tendency for the 'P.L.' numbers to be diminished by this treatment, the effect does not begin to compare with the corresponding changes in consistency. Thus the effect cannot be due simply to mechanical interference with crystal growth. It is known[5] that the sodium chloride content of the mucus is high in the ovulatory phase, but we have found that 'P.L.' numbers cannot be directly related to the amount of sodium chloride. The striking relationship with consistency thus requires further elucidation.

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Production of a Hæmagglutinin during Growth in Tissue Culture of Infectious Canine Hepatitis Virus

Infectious canine hepatitis virus has been successfully grown in tissue cultures of dog kidney epithelial cells[1], virulence for the natural host apparently becoming reduced by continued passage *in vitro*[2]. During an attempt to repeat this attenuation procedure using several recently isolated strains of the virus, an incidental observation was made that tissue culture fluids containing virus could agglutinate avian erythrocytes under certain conditions.

In all instances, trypsinized dog kidney cultures were prepared by the method of Youngner[3], the growth medium consisting of Hanks's solution (80 parts), heated horse serum (10 parts), 5 per cent lactalbumin hydrolysate (10 parts) and containing 100 μgm. or units each of streptomycin and penicillin. After eight days incubation at 37° C., the resulting cell sheets were infected by adding approximately one hundred 50 per cent tissue culture infectious doses (100 $TC50$) of virus. Culture fluids were harvested when cytopathogenic changes were at maximum, usually by the third or fourth day. These fluids, when diluted in 0·15 M sodium chloride buffered at pH 8·0 with 0·02 M phosphate buffer, caused agglutination of a 0·25 per cent suspension of adult fowl erythrocytes. The reaction occurred consistently only at 4° C., where titres of the order of 1 : 160–1 : 320 were shown by three strains of infectious canine hepatitis virus which were in their fifteenth to seventeenth tissue culture passage. At pH 7·5 the same fluids gave end-points of 1 : 40, while at pH levels of 6·0, 6·5 and 7·0 no agglutination occurred. Hæmagglutinin titres were enhanced by several days refrigeration of infected culture fluids, particularly when the latter were buffered at pH 6·5. Following heating at 56° C. for 5 min. (by which time infectivity for tissue cultures was abolished), the hæmagglutinin was found to be reduced by 50 per cent. After a further 25 min. at this temperature, a considerable amount of activity could still be demonstrated.

Hæmagglutination by infectious canine hepatitis virus was of the shield type described for a number of encephalitis viruses[4]. The sedimentation pattern in low-dilution tubes was, however, often disturbed by formation of cell landslides. The end-point was inversely proportional to the concentration of red cells present, maximum titres being shown with 0·25 per cent suspensions. Of erythrocytes derived from a number of animal species and tested at different levels of *p*H and of temperature, only those from newly hatched chicks and older fowls were specifically agglutinated by infectious canine hepatitis virus. Chick embryo red cells failed to react. The ability to hæmagglutinate fowl cells was related to the virus content of a culture fluid and not to any property acquired as a result of passage *in vitro*, a recently isolated virus which initially possessed a *TC*50 of $10^{-1.5}$ and a hæmagglutinin titre of 1 : 8 giving the corresponding figures of $10^{-4.0}$ and 1 : 128 after ten transfers in kidney monolayer cultures.

Hæmagglutination was specifically inhibited by infectious canine hepatitis immune dog serum when the latter, in dilutions up to 1 : 320–1 : 640, was mixed with between ten and twenty agglutinating doses of virus prior to the addition of red cells. Apart from slight non-specific inhibition in dilutions lower than 1 : 10, normal dog sera did not possess this property. The same sera, when assayed for their ability to prevent the normal cytopathogenic effect of approximately a hundred 50 per cent tissue culture infectious doses of virus in tissue cultures, could be diluted 1 : 4,000 (positive) and less than 1 : 10 (negative). The relationship between hæmagglutinin, complement-fixing antigen and infectious unit of infectious canine hepatitis virus is now being studied.

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Isolation of Dehydro*epi*androsterone from an Adrenal Cortical Tumour

Although it is generally assumed that dehydro*epi*androsterone originates from the adrenal cortex[1,2], so far as we know it has not yet been isolated from human adrenal tissue. Using previously published methods[3], we have recently analysed urine specimens from a virilized female patient, aged sixty-two. She excreted approximately 120 mgm./24 hr. of 17-ketosteroids, 70 per cent of which proved to be dehydro*epi*androsterone. An adrenal tumour was suspected.

On operation, a tumour mass weighing (approximately) 1,500 gm. was removed, rapidly frozen and stored in a deep-freeze for two months (we thank Prof. J. Hellström for the opportunity to analyse the tumour). It was then disintegrated and extracted with ethyl acetate. The extract was kept at − 17° C. for four days and the precipitate formed was removed by centrifugation at − 12° C. The ethyl acetate was distilled off and the residue was submitted to four subsequent counter-current distributions between *n*-hexane and 70 per cent methanol, *n*-hexane and 25 per cent methanol, *n*-hexane and 70 per cent methanol and *n*-hexane and 20 per cent ethanol. Following treatment with Girard's reagent *T* [4], the ketonic fraction was submitted to chromatographic separation on alumina[5].

From those fractions, in which dehydro*epi*androsterone usually appears, a crystalline product was obtained (approximately 700 μgm., estimated by the Zimmermann reaction). Following further purification by vacuum sublimation, the crystalline material and its acetylation product were identified as dehydro*epi*androsterone and dehydro*epi*androsterone acetate, respectively, as shown in Table 1.

Table 1

Physico-chemical property	Data for isolated substance as compared with data for authentic dehydro*epi*androsterone
1. Partition behaviour between *n*-hexane and 70 per cent methanol	Same
2. Chromatographic behaviour on aluminium oxide	Same
3. Infra-red spectrogram	Identical
4. Melting point	147–54° (reported for DHEA 137–38° and 153°)
5. Melting point for acetylation product	163–69° (reported for DHEA-acetate 166–67°)
6. Chromatographic behaviour of acetylation product	Same as that of DHEA-acetate
7. Infra-red spectrogram for acetylation product	Identical with that of DHEA-acetate
8. Absorption spectrogram for sulphuric acid chromogen (method of Zaffaroni, ref. 6)	Identical
9. Absorption spectrogram of phosphoric acid chromogen (method of Nowaczynski, ref. 7)	Identical

The isolation of dehydro*epi*androsterone from an adrenal tumour gives further support to the conclusions reached by Bloch *et al.*[5], and suggests that the human adrenal cortex elaborates dehydro*epi*androsterone.

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Enhancement by Deoxyribonucleic Acid of the Catalytic Peroxidation of Pyrogallol

Polysaccharide and other non-protein macromolecules have been found to serve as directive surfaces ('matrices') in the oxidative polymerization of eugenol to lignin[1,2]. Other phenolic monomers and matrices also form systems exhibiting directed polymerization. However, in addition to such effects, certain matrix substances accelerate the oxidation or

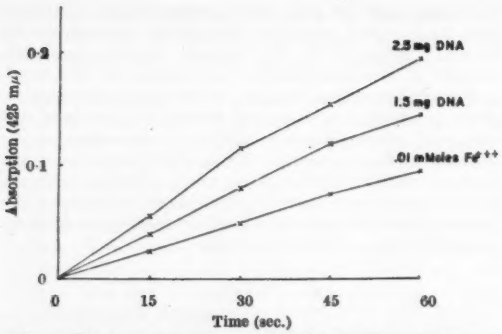

Fig. 1. Time-course of pyrogallol oxidation by Fe+++–hydrogen peroxide measured by appearance of coloured products with absorption maximum λ 425 mμ. Lower curve, 0·01 m.mole Fe+++ in reaction mixtures; upper curves, 0·01 m.mole Fe+++ plus 1·5 mgm. and 2·5 mgm. deoxyribonucleic acid respectively in addition

autoxidation of polyphenols. Particularly striking in this connexion is the effect of salmon sperm deoxyribonucleic acid on the oxidation by Fe^{+++}–hydrogen peroxide of pyrogallol. When deoxyribonucleic acid in amounts up to 3 mgm. per 10 ml. reaction mixture (pyrogallol, 0·1 m.mole; hydrogen peroxide, 0·2 m.mole; potassium dihydrogen phosphate, 0·1 m.mole; Fe^{+++}, 0·01–0·02 m.mole) is present, the rate of peroxidation of the phenol is increased over the control-rate for iron alone as much as 115 per cent (Fig. 1).

Oxidation is measured here by direct reading of absorption (425 mμ) after selected time-intervals in the Bausch and Lomb Spectromic 20 Colorimeter. Deoxyribonucleic acid alone has no effect on pyrogallol oxidation in the absence of iron.

The rate of oxidation of pyrogallol is not a simple linear function of deoxyribonucleic acid concentration, but exhibits a maximum which is a function both of the acid and iron concentrations (Fig. 2). Increases in concentration of deoxyribonucleic acid beyond those shown here effect further reductions in the rate of pyrogallol oxidation; boiling the acid solutions for 10–15 min. effected slight increases in their oxidizing activity when tested later with Fe^{+++} – hydrogen peroxide mixtures. On precipitation of deoxyribonucleic acid from the acid – Fe^{+++} mixtures with ammonium sulphate, 98 per cent of the initial oxidizing activity in the deoxyribonucleic

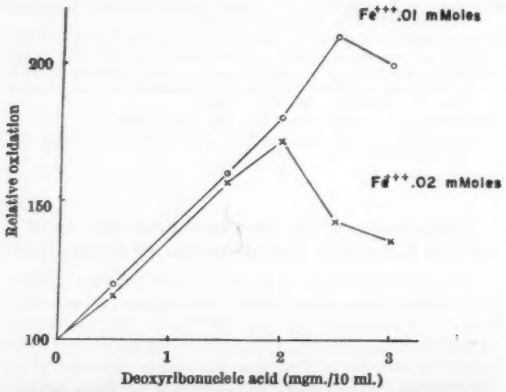

Fig. 2. Relative oxidation of pyrogallol after 30 sec. as a function of deoxyribonucleic acid concentration at two levels of Fe^{+++}

acid precipitate was found to have disappeared, indicating a weak complexing at best between deoxyribonucleic acid and iron.

Mixtures of Fe^{+++} with gelatin, histone, methylcellulose and other macromolecules at low concentrations were found either to have no effect on iron-catalysed peroxidation, or to inhibit it strongly. These observations suggest that the effect of deoxyribonucleic acid, while not necessarily specific, is nevertheless not a simple matter of non-specific adsorption on a macromolecular surface.

It would be premature to ascribe physiological significance to the Fe^{+++} – deoxyribonucleic acid peroxidase model; however, it is reasonable to suppose that nucleic acids might possess a variety of general catalytic properties of biological interest and importance.

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Reactivity of Ionic Detergents with *Micrococcus lysodeikticus*

Weibull has observed that the cell wall of *Bacillus megaterium* can be removed by the action of lysozyme which, under specified conditions, leaves the bacteria otherwise intact[1]. The protoplasts thus liberated have already been the subject of several investigations[2–4] and form a convenient system for directly investigating the effects of detergents upon the exposed plasma membrane. In this communication the action of a series of ionic detergents, each possessing the C_{12} *n* alkyl chain, upon *Micrococcus lysodeikticus* and its protoplasts is reported. The protoplasts of this organism are stabilized in 1 *M* sucrose[5].

M. lysodeikticus was grown in surface culture on a beef tryptic digest agar medium, harvested after 20 hr. growth at 37° and washed three times in distilled water. Treatment with lysozyme at 100 μgm./ml. was carried out for 30 min. at 20° on suspensions containing 10 mgm. bacterial dry wt./ml. in 1 *M* sucrose, 0·05 *M* sodium chloride. The resulting protoplasts were centrifuged and, after decanting, gently resuspended in sucrose/sodium chloride medium. Protoplast suspensions equivalent to 0·5 mgm. bacterial dry wt./ml. were treated with each of four detergents, over a range of concentrations. The detergents used were dodecylamine hydrochloride, dodecyltrimethyl-ammonium bromide, sodium dodecyl sulphate and sodium dodecyl sulphonate. The time course of lysis by these detergents was followed spectrophotometrically at 500 mμ.

In order to compare the lytic activities of the detergents, the loss in optical density occurring after an arbitrary time of 30 min. was determined from the lysis/time curves and plotted as a function of detergent concentration (Fig. 1). The detergent reactivity sequence is $C_{12}H_{25}—NH^+_3 > —N(CH_3)_3^+ > —SO_4^- > —SO_3^-$. The lytic activity of the detergents

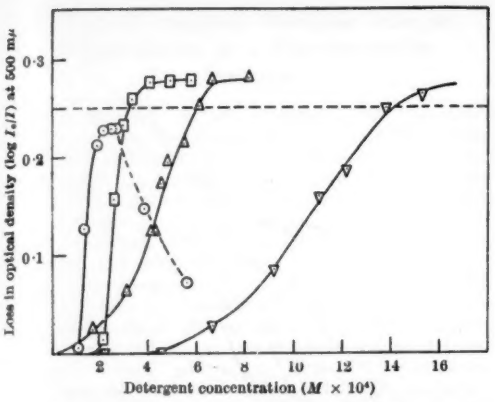

Fig. 1. Reduction of optical density at 500 mμ of *M. lysodrikticus* protoplast suspensions after 30 min. lysis plotted as a function of detergent concentration. 0·5 mgm. bacterial dry wt./ml., 1·0 *M* sucrose, 0·05 *M* sodium chloride. Temperature 22°. ○, Dodecylamine hydrochloride; ⊡, dodecyltrimethyl-ammonium bromide; △, sodium dodecyl sulphate; ▽, sodium dodecyl sulphonate. Broken line indicates 90 per cent lysis

may be expressed in terms of the protoplast lytic concentration defined as that concentration of detergent which, in 30 min., will reduce the optical density of protoplast suspensions by 90 per cent of the loss observed on complete lysis. For dodecylamine hydrochloride, where precipitation with cell constituents affects the results at the higher detergent concentrations, the steep linear portion of the curve was extrapolated to obtain the lytic concentration. The protoplast lytic concentrations ($M \times 10^4$) are for dodecylamine hydrochloride 1·8, dodecyltrimethyl-ammonium bromide 3·2, sodium dodecyl sulphate 6·0 and sodium dodecyl sulphonate 14·2. The corresponding activities relative to dodecylamine hydrochloride are 1·00, 0·54, 0·28 and 0·12 respectively.

The concentrations of the detergents ($M \times 10^4$) required to give 99·9 per cent killing of intact bacteria in 30 min. at 25° are for dodecylamine hydrochloride 2·1, dodecyltrimethyl-ammonium bromide 4·0, sodium dodecyl sulphate 12·0 and sodium dodecyl sulphonate 26·0, the detergents thus showing the same sequence as in the lysis of protoplasts. The bactericidal concentrations are higher than the protoplast lytic concentrations, particularly with the anionic detergents. This is due to the choice of 99·9 per cent killing as against 90 per cent lysis and to the net negative charge on the cell wall of the bacteria. The negative charge will favour combination of the cationic detergents with the cell wall and will be an electrostatic barrier to the passage of detergent anions to the membrane. However, the bactericidal activities of dodecyltrimethyl-ammonium bromide relative to dodecylamine hydrochloride, 0·53, and of sodium dodecyl sulphonate relative to sodium dodecyl sulphate, 0·44, are very close to the same ratios for protoplast lysis and suggest that the same structure is involved in both type of action.

The reactivity sequence is different from that obtained for hæmolysis in which stroma cholesterol is believed to be the reactive site towards ionic detergents[4]. Similarly, anionic detergents are more reactive than cationic detergents towards proteins such as bovine plasma albumin and catalase[7,8]. Thus cholesterol, even if present, and protein are not likely to be the site of attack in the plasma membrane. Infra-red analysis of the lipid isolated from the membrane of *M. lysodeikticus* has indicated the presence of phosphatides. Such lipids, which most probably are orientated in the membrane by virtue of the adlineation of their hydrocarbon chains, could have their organization disrupted by detergents, since they possess ionic groups capable of reaction with both anionic and cationic detergents. It has been shown that lecithin monolayers are more strongly penetrated by dodecylamine hydrochloride than by sodium dodecyl sulphate[9], and in such interfacial reactions negatively charged phosphatides would exhibit even greater reactivity towards dodecylamine hydrochloride. Hence it is suggested that in both the bactericidal action and lysis of protoplasts the site of action of ionic detergents is a phosphatide constituent of the plasma membrane.

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Analysis of Electrophoretic Patterns

In 1950, we described a method[1] for the evaluation of Tiselius electrophoretic patterns based on geometrical analysis of the area under individual Gaussian curves into which the whole pattern may be broken up. The whole process required the measurement of only two parameters. Several related methods based on similar principles have been published[2], but none appears to be as simple and at the same time to afford as high a degree of reproducibility. With the advent of zone electrophoresis in filter paper and its generalized application in many fields, this refined method of analysis attains a new interest.

The distribution of dye-binding particles on a paper pherogram exhibits Gaussian characteristics similar to the refractive index gradients in free electrophoretic patterns. The actual shape and parameters of the curves, however, are not identical, as the causative factors of the distribution are not the same. In free electrophoresis, the gradients around each boundary will depend on the effects of normal diffusion and the electrophoretic heterogeneity. The total diffusion gradient may be represented by a Gaussian distribution curve. In zone electrophoresis in a solid support, the migrating molecules are subject to a number of forces: diffusion, electro-osmosis, suction of buffer from the saturated end parts of

the supporting medium towards the less-saturated centre, and electrophoretic transport with inherent variations due to differences in individual mobilities and also to different path distances along the tortuous capillary channels of the medium. The summation of all these forces also produces distribution curves of Gaussian characteristics.

Assuming that the density of dye at each point of a stained pherogram is proportional to the protein concentration, the same mathematical principles may be applied to evaluate the areas of gradient curves obtained either by free or by zone electrophoresis, as well as many other patterns (diffusion, ultracentrifuge, chromatographic scannings) which may usually be broken up into a series of Gaussian curves.

The Gaussian curve may be represented by the formula:

$$y = \frac{a}{\sigma\sqrt{2\pi}} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

the ordinates being measured from the base line, where the curve tails off asymptotically, and the abscissæ from the maximum ordinate. The integral a is equal to the area under the curve; σ, the standard deviation of the abscissæ, is equal to the width of the curve at the point of inflexion where the slope is a maximum. The height of the curve at its peak where $x = 0$ is equal to y_m. Then we get:

$$y_m = \frac{a}{\sigma\sqrt{2\pi}} \text{ and } a = 2{\cdot}506\,\sigma\,y_m$$

The area a may thus be calculated from two parameters, σ and y_m. Table 1 gives the relation between the abscissæ in units of σ and the corresponding ordinates in percentages of y_m for a series of points on the curve which suffice in most cases for recognizing the trend of the curve and tracing its hidden part down to the base line. The lowest ordinate in Table 1 is practically zero, and the base line may be taken as $3{\cdot}3\sigma$. Many boundaries form symmetrical patterns, but where this is not the case, each branch of the curve is traced independently, the arithmetical mean of the two sigmas being used for calculating the area from our formula, which gives the integral of the total curve. Sigma may also be determined from any two points on the curve by measuring their respective abscissæ x_1 and x_2 and their ordinates y_1 and y_2 and applying the following formula:

$$\sigma = \sqrt{0{\cdot}127\left(\frac{x_2^2 - x_1^2}{\log y_1 - \log y_2}\right)}$$

Several devices may be used for marking the measuring points on the centre ordinate of each curve: a slide-rule may be resorted to, or a table may be constructed for the values of 0·883, 0·607, 0·325 and $0{\cdot}135\,y$, corresponding to ordinates within the range usually encountered. We recommend a simple geometrical method: Draw Fig. 1 on a transparent piece of paper or directly on a screen of ground or milk glass illuminated from behind. Place the graph of the curve over this figure so that the base lines coincide. Displace the graph horizontally until the indicator line just touches the peak point of the maximum ordinate which has to be divided. The other rays will then cut the ordinate at the measuring points.

Table 1

Abscissa	Ordinate
0	100
0·5	88·3
1·0	60·7
1·5	32·5
2·0	13·5
2·5	4·4
3·0	1·1
3·3	0·4

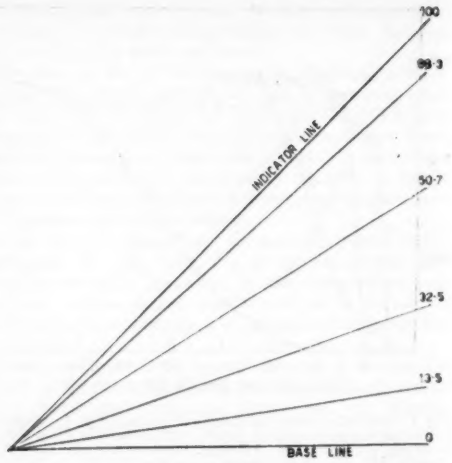

Fig. 1

Summing up, we recommend the following steps: (1) Fix the base line and draw perpendiculars to it through the visible peaks. (2) Divide the maximum ordinate of the fastest (albumin) peak into the measuring distances according to Table 1 and determine the best fitting value for sigma by the method of trial and error. (3) Complete the first curve down to the base line, marking its maximum lateral extension as $3{\cdot}3\sigma$ on the corresponding side of the foot of the maximum ordinate. Although most curves will be found to be symmetrical, each half of the curve may be constructed independently. (4) Note the point where the constructed curve leaves the experimental tracing. The horizontal distance from this point to the nearest peak ordinate corresponds to $3{\cdot}3\sigma$ of the next Gaussian curve, which may now be constructed according to Table 1. (5) Continue in this way until the whole pattern has been decomposed into a number of best-fitting Gaussian curves. (6) Check the sum of the ordinates of overlapping curves at several points, correcting the values for y_m where necessary. (7) Mark any surplus height, that is, any difference between the experimental tracing and the ordinate sum of the constructed curves as an ordinate of a new curve, thereby disclosing hidden gradients.

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Effect of Inorganic Complex Ions on Transmission at a Neuromuscular Junction

Some aspects of the chemical and biological activity of the inorganic complex ions have been previously reported by Beccari[1] and by Dwyer and co-workers[2–4]. These workers have indicated that the complex cations show extremely high chemical stability, and most probably pass through the body unchanged. They also exhibit marked biological activity[4], and when injected intraperitoneally into mice[3] cause paralysis and death by respiratory failure suggestive of curariform activity. We have investigated their pharmacological mode of action on the rat diaphragm–phrenic nerve and toad (*Bufo marinus*) rectus abdominis muscle preparations. Investigations have also been carried out, in collaboration with Dr. Rosamond M. Eccles, of the Department of Physiology, Australian National University, using the toad sartorius nerve–muscle preparation and the isolated superior cervical ganglion of the rabbit.

The following series of inorganic complex ions have been used in this investigation.

(*A*) Amine and ethylenediamine derivatives of cobalt (III). Here the successive addition of unidentate anionic ligands leads to a progressive reduction in the cationic charge by one full unit. This has provided ions ranging from a tervalent cation to a univalent anion; for example, $[Co(NH_3)_6]^{3+}$, $[Co(NH_3)_5(NO_2)]^{2+}$, $[Co(NH_3)_4(NO_2)_2]^{+}$, $[Co(NH_3)_2(NO_2)_4]^{-}$; $[Co(en)_3]^{3+}$, $[Co(en)_2(NO_2)_2]^{+}$.

(*B*) A series of bivalent cations in which metals such as iron, nickel, cobalt, ruthenium and osmium have been co-ordinated with neutral chelating agents such as 2,2′-bipyridine $[Me(bipy)_3]^{2+}$, 1,10-phenanthroline $[Me(phen)_3]^{2+}$ and 2,2′,2″-terpyridine $[Me(trpy)_2]^{2+}$. The cations in this series, while they have the same overall charge, differ in the distribution of the charge over the ligand[2–4]. Further, they are larger than those in series (*A*), are adsorbed strongly on protein and it may be anticipated that both coulombic and van der Waals's forces exert a marked influence in their attachment to an active site.

Unlike series (*A*), the van der Waals's binding of these larger cations may be sufficiently strong to promote their attachment at a cationic site in spite of the anticipated coulombic repulsion.

The lipophilic character of the organic ligands in the cations of series (*B*) may facilitate penetration of biological surfaces by these substances.

(*C*) Stable optical antipodes of selected cations; for example, *d* or *l* $[Ni(phen)_3]^{2+}$; $[Os(bipy)_3]^{2+}$; $[Co(en)_3]^{3+}$.

The results of these investigations indicate that:

(1) Only charged complex ions (cations) exhibit curariform activity which is antagonized on the rat diaphragm–phrenic nerve muscle preparation by potassium ion, eserine and neostigmine and potentiated by atropine. Their action thus resembles that of *d*,tubocurarine rather than decamethonium ion.

(2) The neuromuscular blocking activity of the complex cations on both the toad sartorius and rat diaphragm nerve – muscle preparations appears to take place at the neuromuscular junction. The muscle still responds readily to direct stimulation when there is complete block to indirect stimulation. Normal activity is restored on washing out. However, prolonged immersion (20–30 min.) of the directly stimulated toad sartorius muscle produces a depression of the action potential recorded extracellularly.

(3) The complex cations, in doses which do not cause contracture, strongly depress the action of acetylcholine on the sensitized toad rectus abdominis muscle. They also block junctional transmission in the isolated superior cervical ganglion of the rabbit. The results of post-tetanic stimulation in this latter preparation present features suggestive of a *d*,tubocurarine-like activity[5].

(4) The optically active forms of the same complex cation may show a quantitative difference in their degree of curariform activity on the same preparation; for example, *d*-$[Ru(phen)_3]^{2+}$; *d*-$[Ni(phen)_3]^{2+}$; *d*-$[Os(phen)_3]^{2+}$ are 1·5–2 times more potent than their corresponding *l*-forms on both the toad rectus abdominis and innervated rat diaphragm muscle preparations. However, there is no difference between the activity of *d*- and *l*-$[Co(en)_3]^{3+}$.

(5) The larger complex cations (series *B*) more closely resemble *d*,tubocurarine when one considers both their potency as blocking agents and the recovery time of the muscle preparation on washing them out, while the smaller ions (series *A*) show greater similarity to decamethonium ion, 'Flaxedil' and succinylcholine in these respects (Table 1).

Table 1. Effect of Divalent Neuromuscular Blocking Agents on the Innervated Rat Diaphragm Muscle

Substance	Average dose (mgm./25 ml.) producing complete block in 3 min.	Molarity	Recovery time (min.)
d,Tubocurarine (chloride)	0·2	$1·2\times10^{-6}$ *M*	20–25
Succinylcholine (chloride)	0·25	$2·5\times10^{-5}$ *M*	4–6
$[Ru(trpy)_2](ClO_4)_2$	2·5	$1·3\times10^{-4}$ *M*	16–24
d,*l*-$[Ru(phen)_3]I_2$	8	$3·4\times10^{-4}$ *M*	14–22
Decamethonium (iodide)	6	$4·1\times10^{-4}$ *M*	4–8
'Flaxedil' (iodide)	8	$3·6\times10^{-4}$ *M*	5–9
d,*l*-$[Ru(bipy)_3]I_2$	12	$5·6\times10^{-4}$ *M*	8–12
$[Co(NH_3)_4(NO_2)_2]Cl_2$	16	$2·5\times10^{-3}$ *M*	4–7

(6) Increasing peripheral charge of the complex cations of both series (*A*) and (*B*) is most often associated with an increase in curariform activity on the innervated rat diaphragm muscle preparation. A similar trend has been shown for the direct competitive action of the complex cations of both series with acetylcholine on the toad rectus abdominis muscle preparation. The magnitude of these changes is more marked in series (*A*). The competitive concentration of complex cations (series *B*) was assessed by 6-point assays on this latter preparation. At bath concentrations of 0·1, 0·133 and 0·178 μgm./ml of acetylcholine, the respective concentrations were $[Me(trpy)_2]^{2+}$, 1·25; $[Me(phen)_3]^{2+}$, 2·5; $[Me(bipy)_3]^{2+}$, 10·0 μgm./ml.

Although a comparison between the action of the complex cations on the toad rectus abdominis and rat diaphragm – phrenic nerve muscle preparations is not strictly permissible, it does, however, suggest that these substances may act by direct competition with acetylcholine at the junctional region. This might be due to a competition of electrical fields rather than chemical structures, and is in keeping with the observations of other workers[6].

This relationship is also interesting in that it may give some further insight into the fundamental mode of action of acetylcholine in triggering off events in

junctional transmission, that is, the initiating action of acetylcholine in depolarizing the 'membrane' may lie in the peripheral charge lodged in its cationic head. This is not altogether unreasonable when one considers that the excitable 'membrane' is thought to be composed of a lipoprotein matrix which would be susceptible to the action of charged particles.

A full report of these investigations will be published separately. We wish to acknowledge helpful advice from Prof. W. P. Rogers, Department of Zoology, University of Adelaide, and Dr. J. H. Koch, McMaster Laboratory of the Commonwealth Scientific and Industrial Research Organization, Sydney.

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Absolute Amount of Ribonucleic Acid in Virus and Cytoplasmic Particles

As Frisch-Niggemeyer[1] has pointed out, many viruses of plant and animal origin seem to contain the same quantity of ribonucleic acid, about 2×10^6 gm. per mole of virus. Recently, cytoplasmic nucleoprotein particles have been isolated from yeast[2], pea root (Tsao, P., *et al.*, personal communication) and rat liver[3]. From the particle weight and percentage of nucleic acid found for the particles from either yeast or pea root, a value of $1{\cdot}7 \times 10^6$ gm. for the weight of ribonucleic acid existing in one mole of nucleoprotein may be calculated. A similar amount of ribonucleic acid seems to be contained also in the cytoplasmic particles from rat liver. Thus, in the normal cytoplasmic nucleoprotein particles of both plant and animal origin, the mass of ribonucleic acid appears to be the same and coincides with the amount found in many plant and animal viruses. In view of the diverse origin and very large variations in chemical and morphological complexity and in the absolute amounts of all other chemical constituents, the uniformity of nucleic acid content of these nucleoproteins is felt to be remarkable.

This regularity suggests that one fundamental unit of ribonucleic acid is probably contained in one particle of many viruses and cytoplasmic nucleoproteins in plants and animals. For simplicity, one would like to consider the unit as one ribonucleic acid particle, with a particle weight of about $1{\cdot}7 \times 10^6$. This consideration is tempting in view of the finding[4] that despite the varied range of preparative conditions, the ribonucleic acid isolated from tobacco mosaic virus has a consistent particle weight of $1{\cdot}7 \times 10^6$. The fact that there is evidence[5] that some viruses contain nucleoprotein sub-units does not necessarily contradict this hypothesis. Perhaps in a virus particle these sub-units form a chain of beads, with a thread of the ribonucleic acid particle running along the core.

It has been inferred from crystallographic considerations that nucleic acid in a small virus particle of plant, animal or bacterial origin may consist of identical sub-units[6]. The regularity described in the present communication also suggests that ribonucleic acids of many plant and animal viruses are probably made from nucleotides by one and the same mechanism, and that furthermore this mechanism is probably the same as that which makes cytoplasmic ribonucleic acid of normal plant and animal cells.

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Water and Mucopolysaccharide as Structural Components of Connective Tissue

While tensile and compressive forces must occur throughout an animal body, specific tissues the major function of which is to withstand compression, such as bone, are usually localized. There must be other structures which can resist compression, and water, as a universally occurring and incompressible fluid, could contribute to this property of the structures, provided that free flow of liquid under the applied pressure was prevented. In cell masses exposed to compression, both the colloidal nature of cytoplasm and the barriers provided by cell membranes are likely to hinder such free flow.

Partial immobilization of water in connective tissue may occur according to the following scheme in which three types of frictional interaction are postulated: (1) between interstitial water and high polymeric substances, such as mucopolysaccharides, dissolved in it; (2) between this solution and particles, such as fibres and cells, dispersed in it; (3) between the resultant suspension and the enclosures of the tissue space, and also with any strands of fibres pervading the space. The resulting structure would be visco-elastic, that is, while it could withstand compression it would also slowly flow under prolonged application of a pressure gradient. While no proof is available for this model, which links the molecular and the microscopic structures by a chain of frictional interactions, it is supported by some studies on Wharton's jelly[1], a detailed account of which will be submitted for publication elsewhere.

Some solutions of hyaluronic acid will not pass through pores of the order of 1μ diameter[2], and physical measurements indicate a considerable hydrodynamic hydration of these polymers[3]. Such solutions have a high viscosity[3], and that this will be further increased by particles suspended in solution follows from both observation and theory. The effective

channels in connective tissue are likely to be small, at least in one dimension. From the definition of the viscosity of fluids it follows that with decreasing size of channel the flow of fluid through the channel, under a given pressure gradient, will be progressively retarded.

It is interesting that intimate mixtures of fine fibres and mucopolysaccharides occur in such larger interstitial spaces as the vitreous humour of the eye, cock's comb, Wharton's jelly, and many embryonic tissues the partial rigidity of which could be explained by the previously mentioned hypothesis. The scheme is also consistent with the raising of turgid blebs on injecting fluid subcutaneously, or into Wharton's jelly, and their collapse after the action of hyaluronidase; the equivalent phenomenon in the sex skin of the Rhesus monkey; and the general spreading action of hyaluronidase. Day[4] has shown that substances susceptible to hyaluronidase are held in some meshwork in fascia and that they thereby impede the movement of fluid across the fascia. The scheme proposed here follows that of Day, except that it does not require a definite network of fibres, for which no evidence could be found in Wharton's jelly, and that Day considered only the movement of fluid across the tissue, rather than the effect on the resistance to compression of the tissue itself.

While some mucopolysaccharides may have a special importance in this connexion, any other polymeric substances which have the necessary hydrodynamic properties may act similarly. What part of a deformation is directly reversible will depend on the frictional interaction between the aqueous suspension and the tensile elements. The elastic resistance to deformation will depend on the total work done in stretching the tensile elements, whatever the disposition of the fibres, whether as meshwork or as bladder-like envelopes.

In summary, the mechanical integrity of connective tissue is regarded as depending, in part, on the location of interstitial water in sets of sponges, of which the first is on the molecular level. It follows that the inaccessibility of interstitial water[5,6] may not necessitate a chemical binding.

The hypothesis of a structural function of water may have wider applications. For example, it would seem that a mobile interstitial medium, such as a hæmocœl system, is likely to be found chiefly in organisms which are not subject to large internal pressure differences, that is, animals which have an exoskeleton, or which are supported by buoyancy in water, or which are sluggish and only employ weak and generally distributed muscular contraction.

The structural function of partially immobilized water must have been recognized long ago, yet I could not discover in the literature a formulation of the kind here proposed; I apologize to any who may have come before me. I thank Dr. A. G. Ogston for valuable discussion.

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Ascorbic Acid and Carotene in the Nutrition of the Desert Locust, *Schistocerca gregaria* Forsk.

Newly hatched nymphs of *Schistocerca gregaria* have been reared to adults on the semi-synthetic diet specified in Table 1. Formulated as a friable mixture, the diet was offered in Petri dishes placed on moist cotton-wool (providing drinking water) at the bottom of 2-lb. glass jars, with zinc perches above. Fresh food and cotton-wool were provided every two days when the nymphs were weighed.

Table 1. A Semi-synthetic Diet for the Desert Locust

Cellulose powder	2·0 gm.
Glucose	5·0 gm.
Sucrose	5·0 gm.
Steenbock's salt mixture, No. 40	0·5 gm.
Casein (B.D.H., fat- and vitamin-free)	3·0 gm.
Dried debittered yeast	3·0 gm.
Cholesterol	0·5 gm.
Wheat germ oil	1·0 ml.
Carotene (Light and Co., Natural 88 per cent β-carotene)	25 mgm.
Ascorbic acid	100 mgm.
Choline chloride	100 mgm.
Water	2·5 ml.

At a temperature of 32° C. and an external relative humidity of 50 per cent, with continuous light, and with 5–10 nymphs per jar, development to the adult stage required about 34 days, the percentages of individuals to become adult ranging from 20 to 40. Mean weights when newly fledged were approximately 80 per cent of those of grass-fed controls of which 30–80 per cent became adult in about 28 days. On the artificial diet, nymphs developed a normal, pink tinge in the second instar. In the fourth and fifth instars they were strongly coloured, though the yellow component was subdued compared with that of the grass controls.

If ascorbic acid was omitted from the diet growth was retarded from the start and all died by the fourth instar.

Without β-carotene, growth was retarded, and in the second instar no pink tinge occurred. High mortality reduced survival to the fifth instar to less than 10 per cent. In nymphs which reached the last two instars the yellow body colour was almost lacking, and the reddish suffusion of legs and pronotum was completely absent. In most trials mortality became complete during the fifth instar.

These results suggest that ascorbic acid and β-carotene, or derivative substances, are essential nutrients for *Schistocerca*. Ascorbic acid has been detected in various insects[1], presumably synthesized where the diet does not include it[2]. Improved growth followed its dietary use with *Ephestia* spp.[3] and *Bombyx*[2]; but in the first case this was considered a secondary effect due to the protection of essential fatty acids. It may prove that for insects, as for mammals, ascorbic acid is a vitamin for a few species unable to synthesize their own requirements.

Vitamin A has not been unequivocally demonstrated in any insect, though related carotenoids are of importance in the pigmentation of many species. Fraenkel[4] discussed the possibility of plant carotenoids serving a nutritional function for phytophagous insects, and Goodwin[5] surmised that the carotenoid pigments of locusts are derived from β-carotene in their food. These suggestions here receive experimental support.

As anticipated from Goodwin's[6] account of the relationship between pigment chemistry and external coloration in *Schistocerca*, the omission of carotene from the diet suppressed the yellow colour, due to integumental carotenoid pigments, which

normally appears in the fourth and fifth instars. If, as Goodwin states, the pink colour, normally present in the second and third instars, is due to free insectorubin, its absence when carotene is withheld indicates that carotene is involved in the metabolism of insectorubin.

The poor growth which occurred in the absence of carotene might be a secondary consequence of a dysfunction in pigment metabolism, or an independent effect. Information bearing on this problem has been obtained by substituting vitamin A acetate for carotene in the diet specified. In initial trials growth and survival were equal to those for the carotene diet, but neither the pink nor the yellow colours developed. This suggests that the growth-promoting function of carotene is independent of its role in pigment formation, and may be performed by vitamin A. The latter, however, seems unable to replace carotene in pigment metabolism. It is tempting to infer from this that vitamin A is required by *Schistocerca*. In view of its apparent absence from the tissues[7] it is perhaps more likely that a derivative common to both carotene and vitamin A is the growth factor in question.

It is hoped to extend this work and publish detailed results later. The work has been made possible by a grant from the Anti-locust Research Centre, to the staff of which, in particular Mr. P. Hunter-Jones, my thanks are due for a constant supply of material and much helpful discussion.

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An Extractable Factor in Photosynthetic Phosphorylation

Arnon *et al.*[1] have shown that chloroplasts are able to esterify inorganic phosphate in the light, provided certain co-factors are added. When adenosine monophosphate was added as a phosphate acceptor, adenosine triphosphate was determined as the product of the reaction. Thus light energy is converted into the chemical energy of adenosine triphosphate, in this set of reactions designated photosynthetic phosphorylation.

We have confirmed these observations, following the exact procedure described by Arnon *et al.*[2]. The reaction was usually followed by measuring the change in inorganic phosphate in the system, determined by the method of Taussky and Shorr[3]. In addition, adenosine triphosphate was identified as the major product of the reaction by the highly specific luciferin–luciferase assay of McElroy *et al.*[4].

The Arnon procedure for preparing chloroplasts from spinach leaves (grinding, and one wash, in 0·35 *M* sodium chloride) yields plastids that are highly active in photosynthetic phosphorylation. It was found that when these chloroplasts were subjected to repeated washings in a buffer solution: either (*a*) 0·40 *M* sucrose, 0·05 *M* phosphate (*p*H 7·2) and 0·01 *M* potassium chloride; or (*b*) 0·40 *M* sucrose, 0·05 *M* *tris*(hydroxymethyl)amino methane (*tris*, *p*H 8·0) and 0·01 *M* potassium chloride; their phosphorylative ability was progressively lowered. After five washes, only a small fraction of the original activity is retained (Table 1).

Table 1. Reduction and Restoration of Phosphorylative Ability of Spinach Chloroplasts

Experiment No.	No. of washes	Supernatant added (ml.)	Relative phosphate uptake*
1	0	—	100
	3	—	30
	5	—	12
2	5	—	21
	5	0·10	27
	5	0·40	71
	5	0·95	99
	5	0·95-boiled	14

* 100 corresponds to uptake of 95 per cent of the original inorganic phosphate added at 25 micromoles per vessel.
Each vessel contained approximately 0·5 mgm. chlorophyll, in 3 ml. total volume. The supernatant used in this experiment contained 6·5 mgm. protein/ml. Incubation was for 1 hr. in the light, under nitrogen atmosphere, at 15° C.

The activity of these washed chloroplasts can be completely restored by the addition of a small amount of a soluble chloroplast extract. This extract was prepared by resuspending unwashed chloroplasts in buffer solution (*b*) in the cold. The suspension was allowed to remain at 0° C. for 30 min. and then centrifuged at 17,000*g* for 30 min. The supernatant from this centrifugation was used as a standard source of the extractable factor.

The factor is destroyed by exposure to 100° C. for 3 min. (Table 1). Since it remains in the supernatant even after centrifuging at 140,000*g* for 30 min., it can be regarded as soluble rather than particulate. Its effect is quantitative: the increase in phosphate esterified is approximately proportional to the amount of factor added until saturation is reached.

Several enzymes which might conceivably be a part of the photosynthetic phosphorylation apparatus are now known to be associated with chloroplasts. Preliminary tests seemingly rule out three of these as the (sole) factor removed by our washing procedure.

The first of these is adenylic kinase, recently found in whole chloroplasts[5]. Since adenosine monophosphate is the phosphate acceptor used routinely, adenylic kinase might be required to convert this (with the aid of trace amounts of adenosine triphosphate initially present) to adenosine diphosphate. If this is the true phosphate acceptor in photosynthetic phosphorylation, then the process would not proceed without the initial presence of adenylic kinase. However, although adenosine diphosphate could be substituted entirely for the monophosphate with unwashed chloroplasts, it was entirely ineffective as phosphate acceptor for washed chloroplasts in the absence of the supernatant factor.

An enzyme was recently discovered which permits the net reduction of diphosphopyridine nucleotide by grana[6]. This enzyme might conceivably participate in photosynthetic phosphorylation. However, the usual photosynthetic phosphorylation factor extract had high ability to stimulate washed chloroplasts in photosynthetic phosphorylation, but only low activity in the reduction of diphosphopyridine nucleotide by grana; and conversely, the diphosphopyridine nucleotide-reducing factor, partially purified, had high activity in diphosphopyridine nucleotide reduction but only very low activity in the photosynthetic phosphorylation system.

The third enzyme considered as a possible component was the chloroplast-reduced triphospho-

pyridine nucleotide diaphorase[7], which might be a part of the electron-transferring chain in photosynthetic phosphorylation. Since the enzyme was purified in this laboratory, various fractions during the purification scheme were tried. While activity was observed in some fractions, the ratio of the activities of the various fractions were not at all constant.

The possibility existed that two or three of the above factors are washed out in our procedure, and must be returned simultaneously. However, no additional phosphorylation was produced by adding all three components to washed chloroplasts.

The present evidence therefore seems to rule out adenylic kinase as the sole factor removed by the multiple washes employed. In this respect, photosynthetic phosphorylation by spinach chloroplasts differs from that of photosynthetic bacteria[8]. Experiments so far performed also indicate that the diphosphopyridine nucleotide reducing factor of San Pietro, and reduced triphosphopyridine nucleotide diaphorase, are not the essential factors removed. However, it should be pointed out that these experiments may be complicated by the possible presence of inhibitory factors in the extracts. The possibility is also not excluded that one or more of these known enzymes are involved together with another, unknown factor. Further work on this system is in progress.

A partially purified preparation of the diphosphopyridine nucleotide-reducing enzyme was kindly supplied by Dr. A. San Pietro. Thanks are due to Mr. Wm. Rhodes for aid in measuring adenosine triphosphate by the luciferase assay.

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Variations in the Glycosidic Pattern of Anthocyanins

The distribution tests devised by the Robinsons[1] have long been in use for determining the glycosidic nature of anthocyanin plant pigments. While employing paper chromatographic methods[2] for the same purpose, it has now been observed that the variation in the number and nature of the sugars present in anthocyanins is greater than was originally thought[1]. Anthocyanins have been found which do not fit into any of the glycoside classes described by the Robinsons. One of these was a pelargonidin derivative present as the major pigment in red tubers of cultivated diploid potatoes. Results already reported[3,4] showed that this pigment occurred in association with an acyl group, *p*-coumaric acid and two sugars, arabinose and glucose. The deacylated pigment on the basis of distribution tests and chromatography in *n*-butanol–2 *N*-hydrochloric acid (1 : 1, top layer) and comparison with authentic pelargonin (pelargonidin-3 : 5-diglucoside) was described as a 3 : 5-dimonoside. However, when chromatographed in 1 per cent aqueous hydrochloric acid it travelled farther than the pelargonin marker, suggesting that it had one more sugar residue present in the molecule than pelargonin. This was borne out by later experiments, in which four simpler glycosides were produced from it by controlled acid hydrolysis. From this data, it has been possible to assign the deacylated pigment a provisional structure, namely, the 3-arabinoglucoside, 5-arabinoside of pelargonidin. It is assumed that similar anthocyanin pigments, derived from peonidin, petunidin and delphinidin, which are also present in diploid potatoes are of the same type. Such a glycosidation pattern with two sugars in the 3-position and one in the 5-position has not been described before, but it may be expected to occur in other plants, especially where 3-pentoseglycosides and 3 : 5-dimonosides are known to occur together. In the cultivated diploid potato this glycoside is dominant to a 3-pentoseglycoside (the 3-arabinoglucoside), just as true 3 : 5-dimonosides and 3-monosides have a dominant-recessive relationship in some other plants[5].

Another example of an unusual anthocyanidin glycoside was a cyanidin derivative present in stems and leaves of *Streptocarpus* species and hybrids (Lawrence, W. J. C., unpublished work), and in the berries of the elder, *Sambucus nigra*[6]. The pigment has now been examined in some detail and appears to be a simple molecular complex of cyanidin-3-xyloarabinoside and cyanidin-3-glucoside.

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Role of Nitrogen Concentration on Production of Perithecia in *Penicillium vermiculatum* Dangeard

Sexual reproduction is sometimes dependent on a number of environmental factors. While some fungi normally pass from the vegetative stage to the sexual reproduction stage regardless of their environment, there are others which will not undergo sexual reproduction unless provided with specific external factors, physical or chemical. Hawker[1] demonstrated that both thiamine and biotin are essential for sexual reproduction of *Melanospora destruens*. In the same species she also found a differential effect on sexual reproduction by a number of carbon sources. Other workers[2], experimenting with a number of fungal species, have found numerous other factors to be beneficial or indispensable for sexual reproduction.

A strain of *Penicillium vermiculatum* Dangeard isolated from local soil behaved peculiarly as regards

its sexual reproduction. While it produced perithecia, asci and ascospores on 2 per cent malt extract – agar medium, it would not do so in the synthetic modified Czapek–Dox agar medium, containing, among other ingredients, 4 per cent glucose and 0·2 per cent sodium nitrate (0·033 per cent nitrogen), although there was luxuriant vegetative growth and good asexual reproduction on the latter. 2 per cent malt–agar and Czapek–Dox agar, when mixed in equal volumes, also did not support sexual reproduction. By adding to 1 per cent malt–agar the individual ingredients of Czapek–Dox agar in the same proportions as they are present in that medium, sexual reproduction was checked on addition of sodium nitrate and glucose, completely by the former and partly by the latter. Other ingredients did not interfere in any way. It was likely, therefore, that glucose or sodium nitrate or both influenced perithecial formation.

When, in Czapek–Dox agar, the level of sodium nitrate was kept constant at 0·2 per cent and the glucose-level varied from 0·5 to 5 per cent, no perithecia appeared. Keeping, however, the concentration of glucose in the Czapek–Dox agar constant at 4 per cent and varying the concentrations of sodium nitrate over the range 0·025, 0·05, 0·1, 0·2 and 0·4 per cent, sexual reproduction was favoured at 0·05 per cent and to a less extent at 0·1 per cent. The other concentrations of sodium nitrate did not allow perithecia to develop.

Keeping sodium nitrate concentrations constant at the above five values and varying glucose over the range-levels 0·5, 1·0, 2·0, 3·0, 4·0 and 5·0 per cent in the Czapek–Dox agar medium, it was noted that perithecia developed only at 0·05 and 0·1 per cent sodium nitrate levels. At 0·05 per cent sodium nitrate, the optimum concentration of glucose for perithecial formation was 1·5 per cent, whereas at 0·1 per cent it was 2 per cent.

It seems clear that for production of perithecia in this strain, concentration of nitrogen plays a vital and more important part than concentration of glucose. When sodium nitrate in Czapek–Dox agar was replaced by several other nitrogen sources or by their mixtures in various concentrations, the nitrogen concentration favourable for sexual reproduction was found to be in the same range, namely, 0·0082–0·0165 per cent nitrogen, corresponding respectively to 0·05 and 0·1 per cent sodium nitrate.

Westergaard and Mitchell[3] studied the role of carbon–nitrogen balance on formation of perithecia in *Neurospora crassa*, where low concentrations of glucose and potassium nitrate were found to be favourable. This finding supports our investigation, which suggests that too high a concentration of nitrogen in the medium may hinder sexuality in many fungi.

We thank Dr. D. M. Bose, director of this Institute, for his interest in this investigation, details of which will be published elsewhere.

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Hydrogen Evolution from Soy-Bean Root Nodules

Wilson and Burris[1] reviewed the evidence implicating hydrogenase in biological nitrogen fixation and suggested two working hypotheses for the mechanism of nitrogen fixation which included the participation of hydrogenase. The relation between hydrogenase and nitrogen fixation was strengthened further when Kamen and Gest[2] discovered *Rhodospirillum rubrum* to be a nitrogen fixer and found that nitrogen, either as such or as ammonium, inhibited its photoproduction of hydrogen. Purified hydrogenase preparations from *Clostridium pasteurianum* have shown spectral changes when exposed to nitrogen relative to spectra under hydrogen, oxygen, nitric oxide or a vacuum[3]. Although the initial report[4] of hydrogenase in root-nodule bacteria was not verified by later, more extensive tests[5] with nodules and bacteria from nodules, Wilson[6] recently has reported that a preparation of disintegrated soy-bean nodules exhibited spectral shifts in the presence, as compared to the absence, of hydrogen, suggestive of the activity of a hydrogenase. The absence of a clear demonstration of hydrogenase in nodules often has been cited in discussion of the comparative biochemistry of nitrogen fixation as an irregularity. Evidence from the present communication removes this irregularity and establishes a further point of uniformity among nitrogen-fixing agents.

Excised root nodules of the soy-bean plant have been examined for hydrogenase activity with mass spectrometric methods. Lincoln variety soy-beans were inoculated and grown in sand on nitrogen-free solution[7] or were grown in the field. The plants were harvested, and the root system washed with tap water. The nodules were removed, weighed and equal portions put on moist filter paper in 250-ml. conical flasks. An attachment for evacuating, sampling and refilling with the desired atmosphere was fitted to each flask.

Gas samples were removed periodically and analysed with a Consolidated-Nier isotope-ratio mass spectrometer. All samples were admitted to the mass spectrometer at 30 mm. pressure, and voltages were read for the peaks corresponding to masses 2, 3 and 4. The background correction for each peak was determined before each sample was analysed.

It was anticipated that evidence of hydrogenase activity would be demonstrated most readily by observing an exchange reaction between deuterium in the gas phase and combined hydrogen in the nodules. Although the initial data suggested the occurrence of such an exchange (the ratio of mass 4 (D_2) to mass 3 (HD) decreased somewhat), it also revealed a substantial increase in mass 2 indicative of hydrogen liberation. In subsequent experiments, deuterium was replaced by helium (mass 4) in the gas phase. Results are expressed in Figs. 1 and 2 as the ratio of the abundances of mass 2 to mass 4. The helium provided an internal standard and served as a carrier to aid uniform sampling and measurement.

Fig. 1 indicates that hydrogen (mass 2) was evolved steadily and at a readily measurable rate from detached soy-bean nodules in two independent experiments. The liberation of hydrogen was enhanced greatly in the presence of oxygen. Fig. 1 shows that detached, whole nodules exposed to an essentially anaerobic atmosphere evolved very little if any

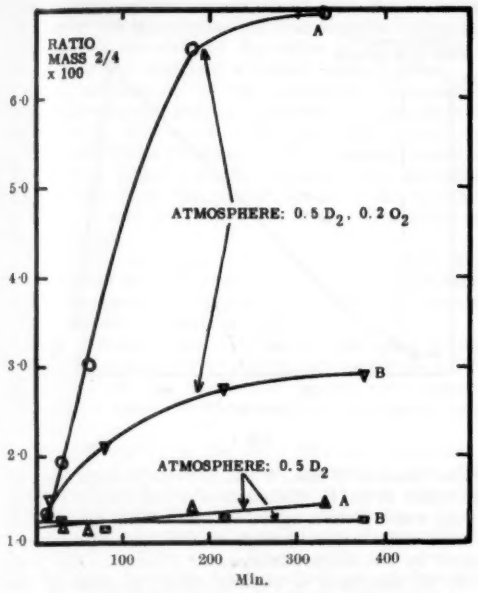

Fig. 1. Effect of oxygen on the liberation of hydrogen from nodules of soy-bean. Two independent experiments, *A* and *B*, are represented

hydrogen, whereas in the presence of oxygen considerable hydrogen was evolved.

Fig. 2 records hydrogen evolution from intact, sliced and ground nodules. It is apparent that slicing the nodules seriously reduces evolution of hydrogen, and that grinding the nodules with a mortar and pestle destroys it completely.

Intact nodules exposed to aerobic atmospheres containing nitrogen-15 incorporated the nitrogen-15 consistently. Nodules heated in a boiling water bath for 10 min. neither evolved hydrogen nor fixed nitrogen-15.

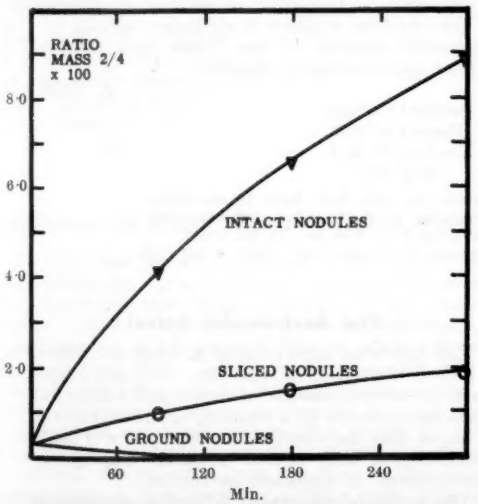

Fig. 2. Liberation of hydrogen from intact, sliced and ground soy-bean nodules under a gas mixture of 0·8 atm. helium plus 0·2 atm. oxygen

There are distinct similarities in the hydrogenase and the 'nitrogenase' of excised soy-bean nodules. Burris *et al.*[8] found the pO_2 supporting optimal nitrogen fixation to be around 0·5 atmosphere. Aprison *et al.*[9] observed that sliced nodules were only about 25–50 per cent as effective as intact nodules in nitrogen fixation, and that no significant fixation of nitrogen-15 could be demonstrated with ground nodules. The decrease of hydrogenase activity with time (Figs. 1 and 2) is reminiscent of the time course of nitrogen fixation in excised nodules as illustrated earlier[10]. It is also interesting to note that the ability of the nodules to evolve hydrogen was lost when hæmoglobin disappeared and was replaced by the typical green pigment in the nodules of field-grown soy-beans.

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A Response of Worker Ants to Dead Ants of their own Species

During experiments on the foraging methods of the ant *Monomorium pharaonis* (L.) in Nigeria, a well-defined response of worker ants to the dead bodies of workers of their own species has been observed. When some of the workers returning to their nest after feeding at a bait were killed by crushing, the passage of ants to and from the bait was interrupted at the place where the crushed ant lay. A worker ant, whether moving on a trail or searching for food independently, which encountered the crushed body of another worker, stopped sharply about 1 cm. from the body, and after a brief antennal palpation of the air towards the body or of the body itself, turned and ran away. The response was to the body and not to the act of crushing or to the experimenter's fingers, as the body of an ant crushed elsewhere and placed in a trail with forceps produced the same effect. The actual presence of the body is not necessary, as the same response was obtained at the point where a body had been laid and after-

Table 1. Behaviour of the First *N* Ants to encounter the Crushed Body of a Worker of their own Species

	No. of ants	No. that turned back	No. that went on
Body of worker from same colony	30	26	4
Spot from which body of worker from same colony has been removed	20	20	0
Body of worker from another colony	20	20	0

wards removed (Table 1). The response was observed equally when the body of a worker from a different colony of *M. pharaonis* was used. The freshly crushed bodies of some other species of ant are, however, treated as food.

This response is quite different from that which occurs when the physical basis of a trail is removed, for example, by wiping it[1]. When cellulose tape was stuck over the trail, the ants collected at each side of the obstacle and eventually crossed it, but never fled or in any way avoided the tape. When the trail was broken by wiping it with cotton-wool soaked in chloroform, ants ran from it at first, presumably while chloroform vapour was still there, but later treated it as they had the cellulose tape. The response to a dead ant resembles that shown to an unpleasant substance such as chloroform, rather than the response to a gap in the physical basis of the trail. The absence of discrimination between ants from the same colony or from different ones shows that colony odour is of no significance in this respect; and, indeed, it may not be developed in *M. pharaonis*, as laboratory colonies can be mixed without difficulty. The same is true of another widely distributed house ant, *Iridiomyrmex humilis* Mayr[2].

Field observations suggest that the response serves to protect the colony against loss of workers to predators, in particular other species of ant, by preventing trails from forming or persisting in 'known' dangerous places, where a worker has been killed. It can also produce anomalous results in experiments in which ants feeding at a bait are prevented from returning to the nest by being killed by the experimenter.

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Osmoregulatory Function of the Contractile Vesicle of *Asplanchna*

The contractile vesicle of the rotifer *Asplanchna priodonta* is a thin-walled muscular sac. It receives fluid from two ducts, each of which is headed by four flame bulbs. When the vesicle contracts it forces the fluid through a third duct which opens on the surface of the animal. Previous records of the rate of contraction of this vesicle have been in disagreement. Masius[1] states that there are ten contractions per min., while Nachtway[2] says that there are only one or two per min. My own observations on freshly collected specimens from Regent's Park Lake show

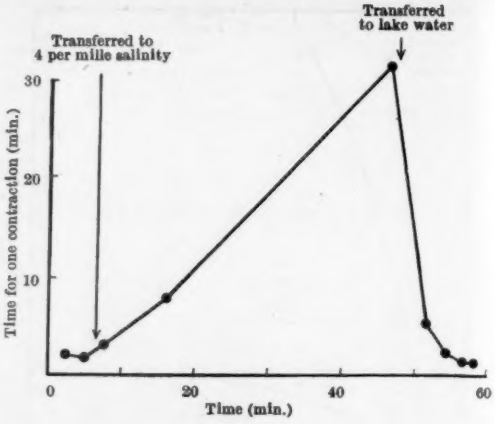

Fig. 1

a mean time of 2 min. 6 sec. for one contraction, in lake water at 20° C. Calculation of the rate of output in lake water gives a figure of 1,972μ^3 per sec., which is more than twice as high as the rate of vacuolar output by the largest freshwater ciliates[3]. The time taken to eliminate a volume equal to that of the body is about 300 min., which is much longer than in most freshwater ciliates and is approached only by *Frontonia leucas*[4].

When the salinity of the external medium is increased to 1‰ the time per contraction increases to 3 min. 8 sec., and when the salinity is increased to 2‰ the time per contraction becomes 8 min. 23 sec. During these experimental changes of the external medium there were no measurable changes in the ultimate diameter of the vesicle. At still higher salinities the interval between contractions becomes too long to observe conveniently. This effect of increase in salinity is reversible. Fig. 1 shows the effect of transferring an individual to a salinity of 4‰ and then back to lake water. Although the contractile vesicle is a complex syncytial organ, its behaviour in relation to the salinity of the external medium is strikingly similar to the contractile vacuole of the Ciliata and indicates a similar osmoregulatory function.

J. Green

Bedford College,
Regent's Park,
London, N.W.1.
Nov. 27.

[1] Masius, J., *Arch. Biol., Paris*, **10**, 651 (1890).
[2] Nachtway, R., *Z. Wiss. Zool.*, **126**, 339 (1925).
[3] Kitching, J. A., *Biol. Rev.*, **13**, 403 (1938).
[4] Metzner, P., "Tabul. Biol.", Berl., **4**, 490 (1927).

The Archimedes Spiral

The following experimental findings are offered in the form of advance information. They are concerned with the after-sensation of movement which follows visual stimulation by a rotating arithmetic spiral. It is hoped that the results to be reported will facilitate psychological and clinical research employing the phenomenon of apparent movement.

The apparent movement following stimulation by the spiral is a central phenomenon. Stimulation of one eye leads to the post-stimulation after-effect by

the non-stimulated contralateral eye. Recent experiments by me have indicated that transfer values from eye to eye are only of the order of 70 per cent—a finding which suggests a strong retinal effect.

The persistence of the apparent movement is dependent upon fixation. Apparent movement occurs after only $\frac{1}{2}$ sec. of prior stimulation but does not occur if the fixation point is changed randomly over much longer periods. A rank order correlation of 1·0 has been determined between the excellence of fixation and the persistence of the after-effect on a small group.

The after-sensation is a distortion of some structured visual field. No effect is noted if, after stimulation, the gaze is projected on to an uncontoured and relatively untextured surface.

It is necessary that the same visual areas be used in stimulation and post-stimulation conditions. The projection of the stationary spiral upon a non-stimulated area results in no after-sensation being noted.

The persistence of the after-effect is curvilinear in relation to time. After 5 sec. stimulation the effect persists from 5 to 8 sec., after 15 sec. the effect persists between 8 and 18 sec., and so on. In two experiments asymptotic values have been achieved between 80 and 100 sec.; continuation of stimulation up to 5 min. has little further effect upon persistence.

Individual differences indicate that the persistence of the after-effect is a personality variable. On the basis of Eysenck's theory of personality, it has been controlled by drugs at acceptable levels of statistical differentiation.

Further experiments have indicated the relative unimportance of other variables within the ranges at which control was exercised. A factorial design has indicated that illumination, visual angle and speed of rotation (50–150 r.p.m.) contribute little to the total effect.

Fuller reports and the possible theoretical implications of these observations will be published at a later date.

The researches outlined above have been made possible by a grant from the Medical Research Council.

H. C. Holland

Institute of Psychiatry
(University of London),
Maudsley Hospital,
Denmark Hill,
London, S.E.5.
Dec. 5.

Reflexion of Radio Waves from the Moon

Kraus[1] has recently reported the reception of impulsive radio signals at a wave-length of 11 metres and concludes that these originate in the planet Venus. On three occasions, a pulse was followed by a weaker one which sounded like an echo. Kraus suggests that these 'echo' signals travelled from Venus to the Earth via the Moon, since the observed time differences of about one second between the primary and secondary pulses were within 10 per cent of the calculated delay times between a direct signal and one reflected from the Moon. This echo phenomenon is then used for making more definite the identification of the radiation as Venusian in origin.

Kraus points out that a Moon echo of the strength observed would require about fifty decibels more echo-power than the Moon would provide as a uniform spherical scatterer of radio waves; in consequence, he postulates specular reflexion from a large flat or slightly concave area. A calculation shows that a flat region would need to be very large indeed; for example, a square-shaped region, with the side of the square at least 160 km. long. Moreover, at least two such regions would be required to account for the observations on different days.

During the period 1947–48, we carried out an extensive series of experiments on radar echoes from the Moon in this wave-length range ($\lambda = 14$ metres)[2]. One type of fading was shown to be related to the Moon's libration, in a way that would be expected only if the lunar surface behaved as a rough scattering surface at this wave-length, with effective reflexion taking place over a large proportion of its surface.

The absolute value of the reflexion coefficient could not be determined, owing to uncertain ionospheric effects; however, the greatest echo amplitude recorded over the whole 50-hr. observing period was approximately equal (to within 1–2 db.) to the level which could be expected from a non-absorbing isotropic Moon and a transparent ionosphere. On no occasion were there any high peaks which could be attributed to specular reflexion from large areas. These experiments were carried out at normal incidence; but it would be surprising if reflexion conditions were significantly different in the circumstances, about midway between normal and glancing incidence, which would be involved in Kraus's case. Also it is worthy of note that, except for one very doubtful case, the reception of solar bursts after reflexion from the Moon has never been reported, in spite of the considerable activity in radio astronomy over the past decade.

Specular reflexion from a portion of the Moon's surface therefore appears very unlikely as an explanation of the secondary pulses reported by Kraus, and should not be used as evidence for a Venusian origin of the primary pulses.

F. J. Kerr
C. A. Shain

Division of Radiophysics,
Commonwealth Scientific and
Industrial Research Organization,
Sydney.
Oct. 10.

[1] Kraus, J. D. *Nature*, **178**, 159 (1956).
[2] Kerr, F. J., and Shain, C. A., *Proc. Inst. Rad. Eng.*, **39**, 230 (1951).

As reported in a communication entitled "The Relation of 11-Metre Solar System Phenomena to Solar Disturbances" (see *Nature*, 179, 371; 1957), it appears very probable that the Moon echoes I reported previously (*Nature*, 178, 159; 1956) did not take place from the surface of the Moon itself, as concluded by Kerr and Shain, but rather from a large cloud of charged particles associated temporarily with the Moon. Their conclusion indeed lends support to the particle cloud hypothesis.

John D. Kraus

Radio Observatory,
Ohio State University,
Columbus 10, Ohio.

A Source of Lithium Light

A stronger source of red light than that provided by the cadmium discharge lamp is desirable for rotatory dispersion measurements. Both lithium carbonate in a flame and lithium chloride in an arc have been used to give the 6708 A. line; but the first source lacks intensity and the second is unstable.

Attempts to produce a lithium lamp on the lines of the laboratory sodium lamp have proved abortive for a number of reasons, the chief of which appeared to be the action of hot lithium on glass. The availability of commercial argon in cylinders renders the use of a lithium metal arc at normal pressure quite feasible. This source is both strong and sufficiently stable for polarimetric work. Fig. 1 shows the construction of the lamp. Both the useful lithium lines at 6708 A. and at 6104 A. are given.

Two points are worthy of note: (*a*) the 'Pyrex' glass shield is not attacked by the hot metal which distils on to the cooler parts; (*b*) the window is made of mica sheet, as an ordinary glass sheet cracks when the nose-piece of the polarimeter is removed from the aperture, due to the sudden advent of cold air.

The lamp in its present form requires cleaning after use (the finely divided metal can be removed with a rag), in which case the glass shield is apparently undamaged. If the metal is allowed to remain on the glass in air the glass is etched. Thus it seems that the difficulties encountered previously from the attacks of the hot metal were due to the presence of oxide or nitride on the surface of the metal. Cleaning of the lamp could be avoided in a commercial lamp by using an all-glass envelope with a magnetically operated screw for controlling the arc. The life of such a lamp would, however, be limited by the distillation of the metal on to the colder parts of the envelope. In view of the stability of glass to hot lithium metal in argon, it seems probable that further development of the normal laboratory-type lamp may now be possible.

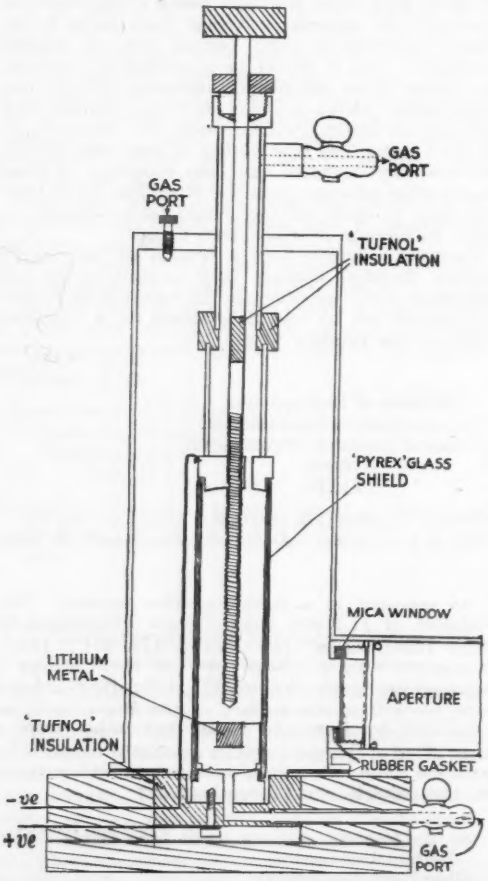

Fig. 1

M. K. Hargreaves

Queen Elizabeth College
(University of London),
Campden Hill Road,
London, W.8.
Nov. 19.

Gallium Oxide Glasses

The preparation and properties of some glasses based on the $CaO—Al_2O_3$ system have already been described by one of us[1].

Experiments which we have carried out more recently have shown that glasses can be made in the $CaO—Al_2O_3$ system with alumina contents between 38 and 65 per cent. These glasses were melted on a scale of approximately 20 mgm. on a resistance-heated platinum alloy wire and were rapidly cooled by switching off the heating current. It is possible that the range of glass formation is even wider than has been indicated, for the limiting compositions were determined by the temperature at which the platinum alloy (20 per cent rhodium, 80 per cent platinum) wire melted. If an attempt is made to make these glasses on a larger scale, then it is necessary to add other oxides. In the work described in reference 1, it was found that if about 6 per cent silicon dioxide is added to the calcium aluminate melts then glasses can be made on a scale of many grams without difficulty. These glasses are characterized by fairly good transmission[2] in the range 1–5μ. An infra-red absorption curve of a particular aluminate glass is shown in Fig. 1.

These results, together with our experience with other fundamentally new types of glass, encouraged us to study glass formation in the $CaO—Ga_2O_3$ system, aluminium and gallium being in the same group of the Periodic Table.

The first step was to make microscale melts on the heated wire in the $CaO—Ga_2O_3$ system. It was found that glasses could be made containing about 60 per cent of Ga_2O_3 but the range of glass formation was only a few per cent and the glasses devitrified even more readily than the aluminate glasses. As expected, the glasses became much more stable when silicon dioxide was added, and a glass of the composition CaO 33·4, Ga_2O_3 59·6, and SiO_2 7 per cent was made on a scale of approximately 5 gm. without much difficulty, although a glass containing 6 per cent silicon dioxide could not be made without some devitrification. The glasses were melted at 1,400° C. for 1–2 hr. in platinum and were cast into disks. The glasses are yellowish-green in colour and have a refractive index of about 1·7. An infra-red absorption curve is shown in Fig. 1, and from this it may be seen

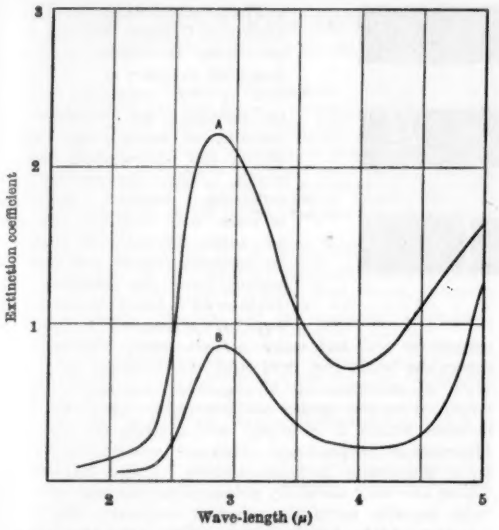

Fig. 1. Infra-red transmission curves of (*A*) a calcium aluminate glass; (*B*) a $CaO—Ga_2O_3$ glass

that the gallium oxide glass has a markedly better transmission than the aluminate glass in the region 1–5μ.

We wish to thank our colleagues, Mr. J. A. James and Mr. C. Whitehead, for carrying out the infra-red measurements.

P. L. Baynton
H. Rawson
J. E. Stanworth

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby. Dec. 12.

[1] Stanworth, J. E., *J. Soc. Glass Tech.*, **32**, 154 (1948).
[2] Stanworth, J. E., *The Industrial Chemist* (Dec. 1951).

A Very Early Photographic Observation of the Spectrum of the Night Glow

It has generally been accepted hitherto[1] that the earliest photographic observations of the spectrum of the night sky were those made by V. M. Slipher with a small, one-prism spectrograph of effective aperture *f*/1·9, at the Lowell Observatory during 1915–19 [2]. They were followed by the spectrographic researches of Lord Rayleigh on the green 'auroral' line (1920–21) [3], and the night-sky continuum (1922–23) [4]; and by J. Dufay, in France, also during 1922–23 [5].

A recent examination of some early reports of Sir Norman Lockyer, then director of the Solar Physics Observatory, South Kensington, has brought to light a reference to what in all probability was the first spectrographic record of the night glow.

It is contained in section IV of a report dated May 1890 [6]: "During a recent voyage on sick leave in the Mediterranean, I tried the effect of exposing a photographic plate to the spectrum of the cloudless sky between the end of twilight and dawn. The exposures on successive nights were integrated, so that at the end no less than 99 hours exposure had been given. No exposures were made during moonlight. Before developing the plate the half of the slit which had been covered during the first exposure was exposed to daylight for 30 seconds, and in this way a suitable comparison spectrum was obtained. The resulting spectrum was rather fainter than the comparison, but showed no notable differences, and it is difficult to say whether it was due to traces of the spectrum of twilight or to the general spectrum of starlight. The object of the experiment was to determine whether skylight was composed of anything but starlight. The instrument used was a direct vision spectroscope, encased in a light-tight box, so arranged that the successive exposures could be made by simply withdrawing a shutter. In this experiment I was assisted by the officers of the R.M.S.S. 'Chimborazo'."

The voyage referred to took place in February 1890 [7]; and, in view of the very restricted spectral response of photographic emulsions at that time, it is not at all surprising that Lockyer failed to detect any characteristic features in the spectrum exposed during the night hours.

Nevertheless, it seems worth while recalling this very early attempt to discover whether or not the spectrum of the night glow differed essentially from that of direct and scattered starlight.

D. R. Barber

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University of Exeter,
Sidmouth, Devon.

[1] Dejardin, G., *Rev. Mod. Phys.*, **8**, 1 (1936). Elvey, C. T., *ibid.*, **14**, 142 (1942). Mitra, S. K., "The Upper Atmosphere", Roy. Asiatic Soc. Bengal, Monograph Series, **5** (Calcutta, 1948).
[2] *Astrophys. J.*, **49**, 266 (1919).
[3] *Proc. Roy. Soc.*, A, **100**, 367 (1922).
[4] *Proc. Roy. Soc.*, A, **103**, 45 (1923).
[5] *C.R. Acad. Sci., Paris*, **176**, 1290 (1923).
[6] Appendix to Minutes of Sixty-third Meeting: Report to Solar Physics Committee, London (May 1890).
[7] Lockyer, T. M., and Lockyer, W. L., "Life and Work of Sir Norman Lockyer", 137 (Macmillan, London, 1928).

A Hexagonal Form of Silicon Nitride

When silicon metal is heated, at various temperatures varying from 1,200° C. to 1,400° C., in a nitrogen atmosphere, a mixture of two forms of nitrides in varying proportions is formed and a typical pattern is shown in Fig. 1*B*. These forms have been separated and are shown in Figs. 1*A* and 1*C*. The X-ray pattern of the first agrees substantially with that indexed by Leslie[1]. We have tentatively indexed the second on a hexagonal basis.

Fig. 1*C* depicts the X-ray pattern of this hexagonal type, Table 1 gives the *d*-spacings and visually observed intensities from the powder photographs, taken with cobalt radiation (λ = 1·789 A.) using an iron filter, and Fig. 2 is a photomicrograph.

Table 1. Powder Photograph Data

A.	Intensity	A.	Intensity	A.	Intensity	A.	Intensity
6·55	m	1·32	w	$1·44_4$	w	$1·14_7$	vw
3·80	m	1·76	ms	$1·34_6$	s	$1·14_4$	vw
3·29	vs	1·59	w	$1·32_6$	vw	$1·09_7$	w
2·67	vs	1·55	vw	$1·29_9$	m	$1·08_5$	w
2·48	vs	1·52	w	$1·27_6$	w	$1·05_6$	m
2·31	w	1·49	vw	$1·25_8$	w	$1·02_4$	w
2·17	m	1·46	w	$1·15_7$	vw	$1·00_6$	w

These spacings give approximate parameters: *a*, 7·60 A.; *c*, 15·70 A. A comparison of this pattern with that obtained from willemite (Zn_2SiO_4) suggests a closely similar structure.

Leslie's data for orthorhombic Si_3N_4 in the A.S.T.M. Index[1] include weak lines at 2·65 and

Fig. 1

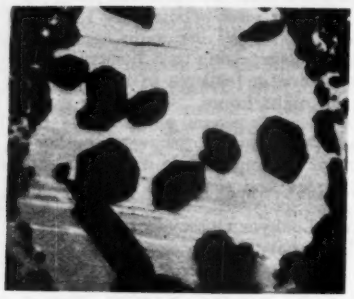

Fig. 2. (× 1,000)

2·48 A. We have been able to prepare samples agreeing in other respects with these data but with these two lines entirely absent. It is evident they are the lines we measure as 2·67 and 2·48 A., in Table 1, and are due to the presence of a small amount of the 'hexagonal' phase in Leslie's sample.

The other strong lines of Table 1 are close to genuine orthorhombic phase lines, and are evidently not detected by Leslie, though they are resolved in good photographs, and are detectable when the two lines mentioned are present.

B. Vassiliou
F. G. Wilde

The British Ceramic Research Association,
Queens Road, Penkhull,
Stoke-on-Trent.
Nov. 22.

[1] A.S.T.M. Index 5—0659. Leslie, U.S. Steel Co., Res. Lab., Kearny, N.J.

Colleges of Advanced Technology

The penultimate paragraph of page 3 of the editorial article in *Nature* of January 5 shows once again the misconceptions which are prevalent regarding the work and function of a college of advanced technology and its relationship to any nearby university or university college. It appears to depend on the assumption that a college of advanced technology will try to attract students who are qualified to enter a university, or that all students who wish to take advanced work should travel the short distance to the university. It also assumes that the future of technician courses has been overlooked. It is difficult also to see why Salford has been singled out. There are colleges of advanced technology in London—none very far from the University of London and its colleges.

The truth is that the Royal Technical College, Salford, does not wish to divert students qualified to enter a university, but it will continue mainly to develop the considerable amount of exceptional talent which the universities cannot reach. Thus its rapidly developing major sandwich courses will continue mainly to take apprentices already in industry (80–90 per cent of whom have the General Certificate of Education at ordinary or advanced level but cannot or will not enter a university) after a joint interview with the firm and the College, with the view of ascertaining those other human qualities which everyone agrees are desirable. They will take courses which it is hoped will qualify for the new Diploma in Technology. This is "broadly equivalent to a university honours degree" (Lord Salisbury). These are very carefully selected people and will join with equally carefully selected students who have progressed 'the hard way' via the ordinary national certificate to make a very considerable increase in the number of technologists which is so much needed by Great Britain.

Salford will, however, also continue to train technicians via the Higher National Certificate courses, and will also continue as in the past to help the cream of these technicians to reach professional status via suitable endorsement subjects. Inside and outside Manchester, however, are many other colleges which will cater for all kinds and grades of technicians. In addition, Salford will continue to share with Manchester the post-advanced courses which were pioneered in this area before the War.

How then can the comment that two major institutions in close proximity are undesirable be justified? On the contrary, it is easier to argue that in a heavily industrialized area, complementary major institutions should be in close proximity. Very special equipment may well be made available in one college to students from the other at suitable times, and there are many other possible advantages, particularly when Lord Waverley's hope is realized. "What I think is most important in that connection (and this is a matter on which other noble Lords have touched) is that persons who have not in the first instance aspired to a university degree, but have obtained some other qualification, either the new 'Dip. Tech.' or recognition by one of the professional institutions—the three engineering institutions for example—should then be regarded as eligible to go forward to a university for post-graduate work; and that the possession of a lower, a first, university degree should not be regarded as a necessary qualification for such further study, whether for a later degree or for research, or whatever it may be" (page 469. Hansard). It should also be noted that Lord Salisbury referred to the diploma in technology as the "first of these awards" by the National Council for Technological Awards.

J. Brentnall
(Chairman of the Governors)

Royal Technical College,
Salford 5.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Council Room of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. L. L. Whyte: "R. J. Boscovich, S.J., F.R.S. (1711–1787) and Mathematical Atomism".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INSTITUTIONS OF CIVIL and MECHANICAL ENGINEERS, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Discussion on the Report on Engineering Education in the Soviet Union.

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. H. S. W. Massey, F.R.S.: "The Use of Rockets and Satellites in the International Geophysical Year".*

UNIVERSITY OF LONDON (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. W. A. Munford: "George Birkbeck and the Mechanics' Institutes".* (Second of three lectures on "English Libraries, 1800–1850".)

PRESTRESSED CONCRETE DEVELOPMENT GROUP (in the Lecture Theatre of the Royal Empire Society, Northumberland Avenue, London, W.C.2), at 6 p.m.—Monsieur A. Mayer: "The Construction of the New Runway at the Maison Blanche Airfield, Algiers".

AUSTRIAN INSTITUTE (at 28 Rutland Gate, London, S.W.7), at 6.30 p.m.—Prof. R. Mitsche: "Recent Developments in Austria in the field of Metallography".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY, at the Woolwich Polytechnic, London, S.E.18), at 7.30 p.m.—Dr. J. D. Kendall: "Organic Chemistry in the Photographic Industry".

Tuesday, February 26

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Analysis of Waveforms", opened by Mr. A. Cooper and Mr. D. A. Drew.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. R. W. Hall, Mr. D. Fraser, Mr. A. L. J. Raum and Mr. P. A. Jenkins: "Structure and Reactivity of Phenol/Formaldehyde Condensates".

INSTITUTION OF MECHANICAL ENGINEERS, STEAM GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Conversion from Coal to Oil Firing".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, Portland Place, London, W.1), at 7 p.m.—Dr. J. H. Westcott: "The Determination of Parameters of a Controller by Simple Frequency Measurements".

ROYAL SOCIETY OF MEDICINE, MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Discussion on "Pharmacological and Medical Aspects of Smoking". Opening speakers: Prof. J. H. Burn, Dr. Richard Doll and Dr. Neville Oswald.

Wednesday, February 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. B. A. Southgate: "Synthetic Detergents—a New Pollution Problem".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Wood and Mr. A. J. Smith: "The Sedimentation and Sedimentary History of the Aberystwyth Grits (Upper Llandoverian)"; Prof. W. D. Gill and Prof. P. H. Kuenen: "Sand Volcanoes on Slumps in the Namurian Basin of Western Co. Clare".

ROYAL SOCIETY OF MEDICINE, ENDOCRINOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "Hormones in Blood". Opening speakers: Dr. E. B. Astwood, Dr. L. T. Samuels, Dr. M. Sonnenberg and Prof. C. J. O. R. Morris.

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. E. J. Burton and Mr. J. R. Joyce: "Measurements of the Size of Droplets from Convergent–Divergent Nozzles used in Oil Burners for Steel Furnaces"; Dr. N. Dombrowski, Dr. P. Eisenklam and Mr. R. P. Fraser: "Flow and Disintegration of Thin Sheets of Visco-Elastic Fuels".*

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. E. W. Pulsford and Mr. N. Veall: "Some Applications of Nucleonics in Medicine".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at 14 Belgrave Square, London, S.W.1), at 6.45 p.m.—Mr. H. E. C. Powers: "Sucrose Crystal Studies".

WOOL EDUCATION SOCIETY (in the Lecture Hall of the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7 p.m.—Dr. C. B. Stevens: "Colour in Wool Fabrics".

Thursday, February 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. G. West: "Interglacial Deposits at Bobbitshole, Ipswich"; Mr. B. W. Sparks: "The Non-marine Mollusca of the Interglacial Deposits at Bobbitshole, Ipswich".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. F. A. Long (Cornell University): "Application of Acidity Functions to the Mechanisms of Acid Catalysed Reactions".

UNIVERSITY OF LONDON (at Swanley Hall, Wye College, Wye, Ashford, Kent), at 8.15 p.m.—Prof. J. Z. Young, F.R.S.: "Brains—Human and Automatic".*

Friday, March 1

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Meeting Room of the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.45 p.m.—Annual General Meeting, followed by Dr. K. A. Williams—Address of Retiring President.

INSTITUTION OF MECHANICAL ENGINEERS, HYDRAULICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Problems in Design of Valves for Liquids".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. H. B. D. Kettlewell: "Industrial Melanism in Moths and its Contribution to Our Knowledge of Evolution".

Saturday, March 2

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. E. T. B. Smith: "The Design and Application of Solid Propellant Rocket Motors".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

NON-MEDICAL ASSISTANT BIOCHEMIST in the Regional Laboratory Service, Royal Northern Infirmary, Inverness—The Secretary and Administrative Medical Officer, Office of the Northern Regional Hospital Board, Raigmore, Inverness (March 2).

SENIOR PHYSICIST (with an honours degree in physics and some experience of X-ray or radioisotope work)—The Secretary, Newcastle Regional Hospital Board, Benfield Road, Newcastle-upon-Tyne 6 (March 5).

LECTURER IN BRITISH ARCHÆOLOGY; and a LECTURER IN PHILOSOPHY—The Registrar, University College, Leicester (March 6).

LECTURER IN PHYSICS; an ASSISTANT LECTURER IN BOTANY; an ASSISTANT LECTURER IN PHYSICS; and an ASSISTANT LECTURER IN ZOOLOGY—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (March 9).

LECTURER IN ROMAN-BRITISH HISTORY AND ARCHÆOLOGY—The Secretary, The University, 38 North Bailey, Durham (March 9).

SENIOR LECTURER or LECTURER IN MATHEMATICAL STATISTICS—The Registrar, University College, Leicester (March 9).

STATISTICIAN (with an honours degree in mathematics or science, and preferably postgraduate experience in statistical techniques as applied to agriculture, horticulture or biology generally) for work in connexion with an experimental and research programme on glasshouse crops, mushrooms, and outdoor flowering plants—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (March 10).

VICE-PRINCIPAL (graduate of good academic standing and administrative experience, and preferably a technical or scientific qualification) OF KUMASI COLLEGE OF TECHNOLOGY—Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (March 11).

TUTOR or LECTURER (woman, with special qualifications in either experimental or theoretical physics) IN PHYSICS—The Treasurer, Somerville College, Oxford (March 12).

SENIOR LECTURER (preferably with an interest in experimental physics) IN PHYSICS at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 13).

LECTURER IN THEORETICAL CHEMISTRY—The Registrar, The University, Bristol (March 15).

LECTURERS (2) IN PHYSICS; and LECTURERS (2) IN CHEMISTRY, at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (March 15).

READER IN MATHEMATICS at Royal Holloway College, Englefield Green, Surrey—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

LECTURER or ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Nottingham (March 30).

LECTURERS IN EXPERIMENTAL PHYSICS—The Secretary of University Court, The University, Glasgow (March 30).

RESEARCH ASSISTANT (honours graduate in chemistry of a British university, and preferably some relevant experience IN PUBLIC HEALTH ENGINEERING in the Department of Civil Engineering—The Registrar, King's College, Newcastle-upon-Tyne (March 30).

UNIVERSITY STUDENTS AND FELLOWS for experimental or theoretical research in nuclear and elementary particle physics—The Professor of Natural Philosophy, The University, Glasgow (March 30).

LECTURERS or ASSISTANT LECTURERS IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 31).

WILLIAM DICK CHAIR OF VETERINARY SURGERY in the Royal (Dick) School of Veterinary Studies—The Secretary, The University, Edinburgh (April 30).

ROYAL DUTCH SHELL STUDENT (honours graduate in geology, with mathematics and/or physics at ancillary level) IN GEOPHYSICS—The Registrar, Imperial College of Science and Technology, London, S.W.7 (June 1).

ASSISTANT, Grade B (preferably honours graduate, with teaching, research or industrial experience) in PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

ASSISTANT WARDEN (male, with an honours degree in zoology or botany, together with a general interest in field subjects, particularly marine biology) at Dale Fort Field Centre, Haverfordwest Pembs—The Secretary and Treasurer, Field Studies Council, Balfour House, 119–125 Finsbury Pavement, London, E.C.2.

CHAIR OF GEOGRAPHY—The Registrar, The University, Bristol.

CURATOR (Ph.D. or equivalent with specialized training in palæontology) OF GEOLOGY, for duties which include the classification and organization of university collections of fossils, rocks and minerals;

with an additional light teaching load and responsibility to carry out research work—The Chairman, Department of Geology, Hamilton College, McMaster University, Hamilton, Canada.

Electronic Engineers and Physicists (with, or obtaining, a first- or second-class honours degree or equivalent with experience or interest in radio, radar and communications; instrumentation for telemetry and other measurements; electronic devices; application of advanced techniques in other fields, for example, armament) at Ministry of Supply Research and Development Departments chiefly at Malvern, Worcs; Farnborough, Hampshire; and Sevenoaks, Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.514/6A.

Empire Rheumatism Council Fellows (2) (with medical or scientific qualifications) to prosecute research in the field of rheumatism—The General Secretary, Empire Rheumatism Council, Tavistock House (N), Tavistock Square, London, W.C.1.

Head of the Department of Mathematics—The Secretary, Sir John Cass College Jewry Street, London, E.C.3.

Laboratory Superintendent (A.I.M.L.T. and wide experience of medical laboratory routine technique) in the Sierra Leone Government Medical Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/43925/NF.

Lecturer (with research interests in either inorganic or physical chemistry) in Inorganic Chemistry—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

Lecturers (with an engineering or a science degree, and preferably lecturing experience, and a specialist knowledge of electrical engineering, electronics, servo-mechanisms, or guided missiles) at the R.E.M.E. Training Centre, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. D.387/6A.

Sleeping Sickness Control Officer (preferably single, with a good general education and agricultural training or knowledge of surveying, mapping, entomology or botany) in the Northern Nigeria Government Medical Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3A/43728/NF.

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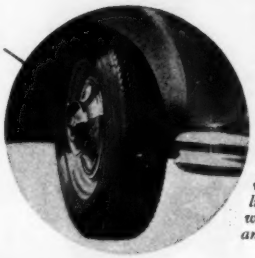

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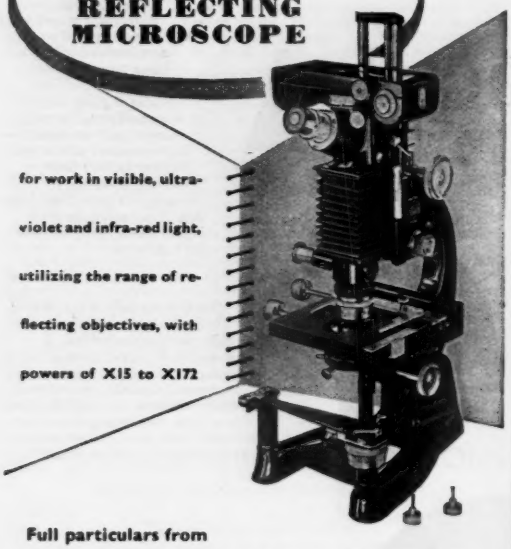

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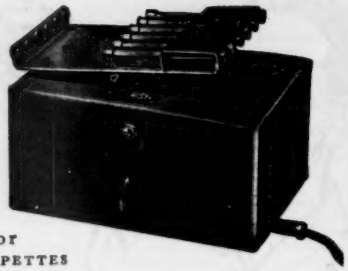

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